US Army Corps
of Engineers
Los Angeles District

SANTA ANA RIVER BASIN, CALIFORNIA

Santa Ana River

Design Memorandum No. 1

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM including Santiago Creek

VOLUME 5
OAK STREET DRAIN

August 1988

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- Outlet Channel
- Hydraulic Design

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This volume accompanies the Main Report and Supplemental Environmental Impact Statement for the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago Creek and contains the general design for the Oak Street Drain.

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Design Memorandum No. 1
Volume 5
Santa Ana River Mainstem
including Santiago Creek, California
Phase II General Design Memorandum

OAK STREET DRAIN

SYLLABUS

This volume accompanies the Main Report and Supplemental Environmental Impact Statement for the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago Creek and contains the general design for the Oak Street Drain.

The recommended plan for Oak Street Drain consists of a concrete channel beginning at the existing Oak Street debris basin and extending over 3 miles to the confluence with Temescal Wash. The channel is designed to provide 100-year level of protection. Total project first cost is estimated at $20,652,000. The economic data for the project is contained in Volume 9, "Economics and Public Comment and Response".

PHASE II GDM LISTING OF VOLUMES

Main Report and Supplemental Environmental Impact Statement	
Volume 1	Seven Oaks Dam
Volume 2	Prado Dam
Volume 3	Lower Santa Ana River (Prado Dam to Pacific Ocean)
Volume 4	Mill Creek Levee
Volume 5	Oak Street Drain
Volume 6	Santiago Creek
Volume 7	Hydrology
Volume 8	Environmental
Volume 9	Economics and Public Comment and Response

PERTINENT DATA OF OAK STREET DEBRIS BASIN*

	As Built in 1979
Drainage Area of debris basin (sq. mi.)	6.2
Design Discharges	
Maximum Probable Flood:	
Peak (cfs)	7,740
Debris Production	
One major storm (ac. ft.)	253***
Debris Basin	
Embankment (rolled earthfill)	
Length (ft.)	2,100
Crest elevation (ft. NGVD** of 1929)	1,034
Maximum height above streambed (ft.)	24
Spillway	
Crest elevation (ft. NGVD of 1929)	1,022
Crest length (ft.)	120
Outlet channel (Circular Conduit)	
Diameter (ft.)	4.0
Length (ft.)	202
Intake elevation (ft. NGVD of 1929)	1,010.25
Outlet elevation (ft. NGVD of 1929)	993.0

*Built by Riverside County Flood Control and Water Conservation District.
**NGVD = National Geodetic Vertical Datum of 1929.
***This volume is adequate for a 100-year flood design of 224 acre-feet.

PERTINENT DATA - OAK STREET DRAIN CHANNEL

Drainage Area (sq. mi.)	15
Design Discharges	
Upstream end (cfs)	4,300
Downstream end (cfs)	8,000
Channel length (ft.)	18,800
Channel width (ft.)	12 to 30

CONTENTS

Contents (Continued)

Contents (Continued)

Tables

Figures

Plates

Plates (Continued)

Appendixes

I. INTRODUCTION

Authorization

1-01 Authorization for construction of the project is contained in the Water Resources Development Act of 1986, (P.L. 99-662). The project for flood control is contained in the Report of the Chief of Engineers for the Santa Ana River Mainstem, including Santiago Creek, California, dated January 15, 1982, except that, in lieu of the Mentone Dam feature of the project, the Secretary is authorized to plan, design, and construct a flood control storage dam on the upper Santa Ana River. The full authorization language is presented in the Main Report.

Scope and Purpose of Report

1-02 This volume of the Phase II General Design Memorandum (GDM) describes the existing physical conditions in the project area and provides definite design for Oak Street Drain. This Phase II GDM provides the basis for project features, establishing the project rights-of-way and easements, updating the project costs, assessing the environmental effects, and preparing contract plans and specifications.

Local Cooperation

1-03 The division of Federal and non-Federal responsibilities for local cooperation are outlined in the main report.

II. PROJECT PLAN

Description of the Project Area

2-01 Oak Street Drain (pl. 1) is a tributary of Temescal Creek and is located within the incorporated limits of the City of Corona in the northwestern corner of Riverside County, California. The drainage area of Oak Street Drain at Temescal Creek confluence is approximately 15 square miles; the majority of the drainage area is located within the steep northern slopes of the Santa Ana Mountains just beyond the southern border of the City. Hagador, Tin Mine, and Kroonen Canyons constitute approximately 6 square miles of the drainage area at the upstream end of Oak Street Drain, and the remaining 9 square miles of the drainage area are located to the east and north of the above three canyons. Oak Street Drain begins at the confluence of Hagador, Tin Mine, and Kroonen Canyons, flows northward for a distance of approximately 1.8 miles, and then winds through the urbanized portion of the City of Corona for another 1.8 miles before discharging into Temescal Wash. The terrain of canyons is rugged and the existing ground elevations in the canyons range from 3,800 feet above the National Geodetic Vertical Datum (NGVD) of 1929 at the headwater to 1,040 feet at the canyon mouth. Below the canyon mouth is the rather flat and wide alluvial plain where the ground elevations vary from 1,040 feet to 570 feet at the confluence of Oak Street Drain with Temescal Creek.

2-02 Most of the alluvial plain along the upstream portion of Oak Street Drain is cultivated, and the downstream end of the plain is urbanized, including a major freeway, trailer parks, schools, many commercial establishments, and large residential tracts.

Existing Flood Control Facilities

DEBRIS BASIN

2-03 In order to minimize the damages caused by flooding along Oak Street Drain in the City of Corona, the Riverside County Flood Control and Water Conservation District, with assistance from Soil Conservation

Service of the U.S. Department of Agriculture, completed construction of a debris basin in October 1979 at the confluence of Hagador, Tin Mine, and Kroonen Canyons. The basin (pl. 1 and figs. 1 and 2) was designed to control floodwaters that are heavily laden with debris from the six-square-mile drainage area of the three canyons. The compacted earth embankment forming the debris basin has a crest length of 2,100 feet at an elevation of 1,034 feet above the National Geodetic Vertical Datum (NGVD) of 1929, and has a maximum height of 24 feet above the natural streambed. The debris basin was designed for a debris storage capacity of 253 acre-feet (the survey of January 1983 indicated only 242 acre-feet of storage capacity was remaining), and a broad-crested spillway was designed to convey a flood of 7,700 ft^3/s. The rectangular reinforced concrete spillway has a crest width of 120 feet, a length of 171 feet, and wall heights ranging from a maximum of 12 feet at the spillway crest to 4 feet at the upstream entrance. A 48-inch-diameter reinforced concrete pipe under the spillway drains the residual water in the debris basin.

CHANNEL IMPROVEMENTS

2-04 Flood control facilities along Oak Street Drain downstream from the debris basin to Temescal Wash have been provided by Riverside County Flood Control and Water Control District; however, these improvements are limited to stabilizing the banks and invert of the channel and are inadequate to provide the necessary protection against major design floods. Existing flood control facilities are:

a. From the debris basin to the Mangular Channel, existing improvements consist of approximately 1.5 miles of rail and wire-mesh fence along the toe of the existing arroyo banks. The fence confines the alignment and capacity of the excavated and unrevetted soft bottom channel to a base width of 20 feet and an average height of 5 feet.

b. Approximately 1,000 feet of rectangular concrete channel is provided at the confluence with Mangular Channel, (fig. 3). Another 2,300 feet of rectangular section is provided in the existing drain between the north side of Riverside Freeway and the Santa Fe Railroad Crossing (fig. 4). The 20-foot wide rectangular channel is formed by two 6.5-foot high retaining walls with 4-foot wide footing. The channel invert is unlined, with the exception stabilizers placed at strategic locations.

c. A 520-foot long concrete trapezoidal section is provided in the vicinity of Ontario Avenue (fig. 5), and another 3,700 linear feet of trapezoidal channel is built between the downstream end of the rectangular section at the confluence with Mangular Channel and Lincoln Avenue (fig. 6). The trapezoidal channel has a bottom width of 13.5 feet, side slopes of 1V on 1.5H, and height of approximately 6 feet.

Figure 1. Concrete spillway and 48-inch outlet pipe of the existing debris basin.

Figure 2. Stilling basin and Oak Street Drain downstream of the spillway.

Figure 3. Confluence of Oak Street Drain and Mangular Channel (right).

Figure 4. Rectangular channel downstream of Railroad Street.

Figure 5. Trapezoidal Channel upstream of Ontario Avenue.

Figure 6. Existing Oak Street Drain downstream of 10th Street.

d. Under Lincoln Avenue and the Riverside Freeway is an existing 750-foot long, 8-foot high, and 10-foot wide reinforced concrete culvert.

e. Between the Santa Fe Railroad and Lincoln Avenue, a distance of approximately 2,380 feet, the existing channel is unlined with a trapezoidal cross section, having a base width ranging from 20 to 50 feet and a height of about 10 feet.

f. The existing Lincoln Avenue channel is a partially improved channel from Torquoise Drive to Oak Street Drain. The invert and the bottom 3 feet of the trapezoidal channel are lined with reinforced concrete, and the upper banks of the channel are formed by compacted earthfill. The overall depth of the channel is 6 feet.

g. The existing Mangular Channel was built by the Riverside County Flood Control and Water Conservation District. The channel is rectangular in cross section with a base width of 18 feet and a wall height of 5.5 feet.

h. The existing Main Street channel at the confluence with Oak Street Drain is formed by unrevetted levees with an invert width of approximately 20 feet and a height of about 14 feet.

The Flood Problem

2-05 The flood problem along Oak Street Drain can be attributed to two factors: (1) the existing flood control facilities cannot withstand the high velocity flow in the channel, and (2) the existing undersized channel cannot convey the 100-year design flood without overtopping its banks.

The Authorized Plan

2-06 The flood control plan along Oak Street Drain is essentially the same plan as recommended in the Chief of Engineers Report dated 15 January 1982, which was authorized by Section 401(a) of the Water Resources Development Act of 1986 (PL 99-662). However, in transmitting the report to the Congress on 5 January 1985, the Assistant Secretary of the Army (Civil Works) recommended that construction of the Oak Street Drain should provide no greater than 100-year protection unless a higher level could be economically justified. Accordingly, the plan is designed for 100-year protection.

The Plan Recommended in This Report

2-07 The recommended flood control plan for Oak Street Drain Channel is based on the authorized plan except that the channel will be extended 0.4 mile downstream to Temescal Creek Channel in order to provide an adequate point of disposal for the design flood.

a. Beginning at the upstream limit of the proposed channel, a 900-foot long transition will be provided downstream from the existing spillway (Sta. 205+34.58) of the debris basin. A rectangular concrete transition section will have variable widths ranging from 120 to 30 feet and wall heights varying from 7.0 to 4.0 feet. A 5-foot wide low flow channel will be provided for the existing 48-inch drain pipe from the debris basin. The low flow channel (pl. 2) will be 250 feet in length at a slope of 0.01 until it day-lights with the channel invert, and will be located within this transition section.

b. A 3.0-mile long reinforced concrete rectangular section will be constructed between station 196+34.58 and station 35+00, which is located approximately 580 feet downstream of the Santa Fe Railroad bridge (pls. 3 through 16). The rectangular channel will have a variable width ranging from 12 to 20 feet, and wall heights varying from 5.5 to 12.0 feet. Near the downstream end of this reach, between station 79+00 and station 65+40, a concrete box section will be provided under the existing streets and the Riverside Freeway. Confluence structures for collecting runoff from local drainage areas, transition sections, and bridges for providing vehicular crossings to the public, will be provided as necessary at various locations.

c. The reinforced concrete box sections under public streets and Riverside Freeway will consist of two types. For the upstream 1,130 linear feet (sta. 79+00 to sta. 67+70), double boxes will be constructed, having wall heights ranging from 11.0 to 9.5 feet and a total width of 28 feet including a 12-inch divider wall. The remaining 230-feet (sta. 67+70 to sta. 65+40) under the Riverside Freeway will be a single box. In order to minimize construction cost and to avoid interference with the traffic on the Riverside Freeway, the box will be precast in 5 to 10-foot long sections and will be installed by jacking into place.

d. After a 100-foot transition (sta. 35+00 to sta. 34+00) from a rectangular to trapezoidal section, the proposed channel improvement between station 34+00 and station 17+30 will be trapezoidal in cross section, with a base width varying from 20 feet to 30 feet, height ranging from 18.0 to 11.5 feet, and side slopes of 1V on 2H. The invert and side slopes of the upstream 400 feet of the trapezoidal section will be revetted with 36 to 15 inches of grouted stone, respectively, and the next 1,100 feet of channel slopes and invert will be protected by a layer of 15-inch grouted stone. The invert and side slopes of the remaining 270 feet of the channel will be revetted with reinforced concrete slab.

e. A 186-foot long confluence structure (pl. 17) will be constructed at Oak Street Drain channel between station 122+29 and station 124+15 for Lincoln Avenue Channel; in addition, a

114-foot long rectangular channel and a 50-foot long concrete transition section will be provided along Lincoln Avenue Channel to intercept concentrated flows from the tributary area. The rectangular section will be 12 feet wide and 9 feet high, while the transition section will have a base width of 12 feet, side slopes of 1V on 2H, and a height of 7 feet.

f. A confluence structure for Mangular Channel (pl. 17) will be provided at Oak Street Drain between station 112+09 and station 113+34, which is located approximately 120 feet downstream of the Mangular Channel. An 18-foot wide, 120-foot long rectangular channel with wall height of 5.5 feet will be constructed from the confluence structure to join the existing Mangular Channel.

g. A 200-foot long confluence structure (pl. 15) will be provided for Main Street Drain at station 27+00. A trapezoidal section of approximately 250 feet in length will be extended from Oak Street Drain to intercept flows from Main Street Drain. The extention will have a 20-foot wide base, 1V on 2H side slopes and a height of 18 feet.

Consideration of Alternative Solutions

GENERAL

2-08 Due to change of site conditions since the completion of the Phase I GDM, the proposed flood control project was re-valuated by considering its economy, safety, ability to function as an independent project, and environmental impact. Following paragraphs describe the alternatives that were evaluated.

DEGREE OF PROTECTION

2-09 The Phase I GDM recommended a flood control project which would provide standard project flood protection along Oak Street drain in the City of Corona. In order to provide standard project flood protection with the design debris volume of 305 acre-feet, it would be necessary either to raise the existing debris basin embankment and modify its spillway (currently adequate for 100-year flood capacity), or to excavate the basin to provide an additional 63 acre-feet in storage capacity. The improved Temescal Wash channel located at the downstream confluence with the Oak Street Drain is also sized for 100-year flood capacity. However, in a report to the Congress, the Assistant Secretary of the Army (Civil Works) recommended that construction of the Oak Street Drain should provide no greater than 100-year protection unless a higher level could be economically justified. Studies indicate that provision of a flood control project larger than 100-year flood is not economically justified. Therefore, a 100-year flood design channel is recommended.

DOWNSTREAM END OF CHANNEL

2-10 The Phase I GDM recommended that the downstream limit of Oak Street Drain Channel would be located approximately 900 feet downstream from the existing Santa Fe Railroad. Stone revetment would be placed on the embankment of an existing sewage treatment pond (sta. 29+00) which will be located about 200 feet further downstream from the end of the channel. Floodwaters from Oak Street Drain Channel would have discharged into the unimproved Temescal Wash downstream from Lincoln Street and then into the reservoir area of Prado Dam.

2-11 Since the completion of the Phase I GDM in September 1980, the Riverside County Flood Control and Water Conservation District has improved the Temescal Wash from Lincoln Avenue upstream to Santa Fe Railroad. Improvements were completed in 1984. At the confluence with Oak Street Drain, the improved Temescal Wash Channel is trapezoidal in cross section with a bottom width of 80 feet, height of 8 feet, and side slopes of 1V on 2H. The slopes are revetted with 2 feet of 1/4-ton stone over 8 inches of filter blanket. A 20-foot-wide access road for operation and maintenance purposes is provided on top of the channel banks. In addition, in 1986, the City of Corona improved Lincoln Avenue by raising its present grade approximately 11 feet, and provided a single bridge 170 feet in length at Temescal Wash. Improvement of Lincoln Avenue will be completed prior to construction of Oak Street Drain Channel. Thus, uncontrolled floodflows from Oak Street Drain of the Phase I GDM design would cause severe damage to the south bank of the improved Temescal Wash and to the improved Lincoln Avenue embankment unless the channel is extended about 1,100 feet further downstream to form an adequate confluence with Temescal Wash Channel just upstream from Lincoln Avenue.

2-12 Re-evaluation of the phase I GDM design was conducted, giving consideration to an extension of the Oak Street Drain channel to form a confluence with the improved Temescal Wash permitting controlled flows to pass under the proposed Lincoln Avenue bridge. An extension of the Oak Street Drain was found to be necessary to provide a proper confluence and an adequate point of disposal for the design floodflows.

III. HYDROLOGY

Introduction

3-01 This section presents a brief description of the Oak Street Drain drainage area and presents the design discharges for the recommended channel. Additional detailed information on the development of the hydrology is given in Volume 7 of the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago Creek.

General

3-02 The location and boundary of the Oak Street Drain drainage basin is shown in figure 7. Hagador, Tin Mine, and Kronen Canyons rise in the steep eastern slopes of the Santa Ana Mountains and combine at the Oak Street debris basin to form the inlet of the Oak Street Channel. The drainage area at the debris basin is approximately 6 square miles of National Forest Land that is expected to remain largely undeveloped during the project life. The channel receives flow from the basin and extends northward over a wide alluvial plain, through the western portion of the City of Corona to Temescal Wash. The downstream alluvial plain is partially urbanized and is expected to be completely urbanized at the end of the project life. Flows from Mabey Canyon debris basin to its downstream Mangular Border Drain, Lincoln Avenue Drain, and Main Street Drain enter Oak Street channel upstream of its confluence with Temescal Wash. The total drainage area is approximately 15 square miles. Elevations vary from 3,800 feet at the headwaters to 1,000 feet at the debris basin to 570 feet at the mouth. Slopes range from about 600 feet per mile in the upper basin to 200 feet per mile in the lower basin.

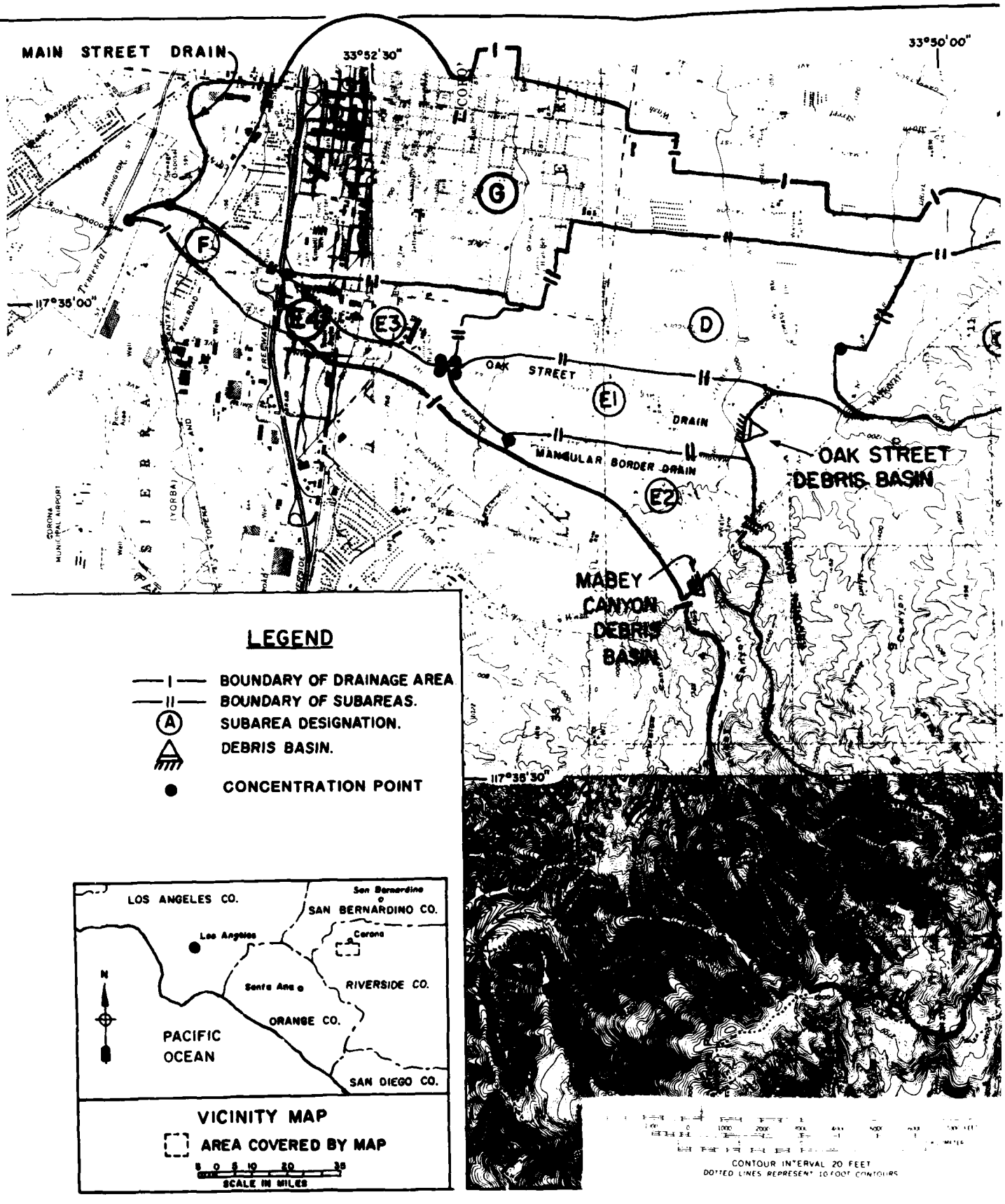
Design Flood Peak Discharge

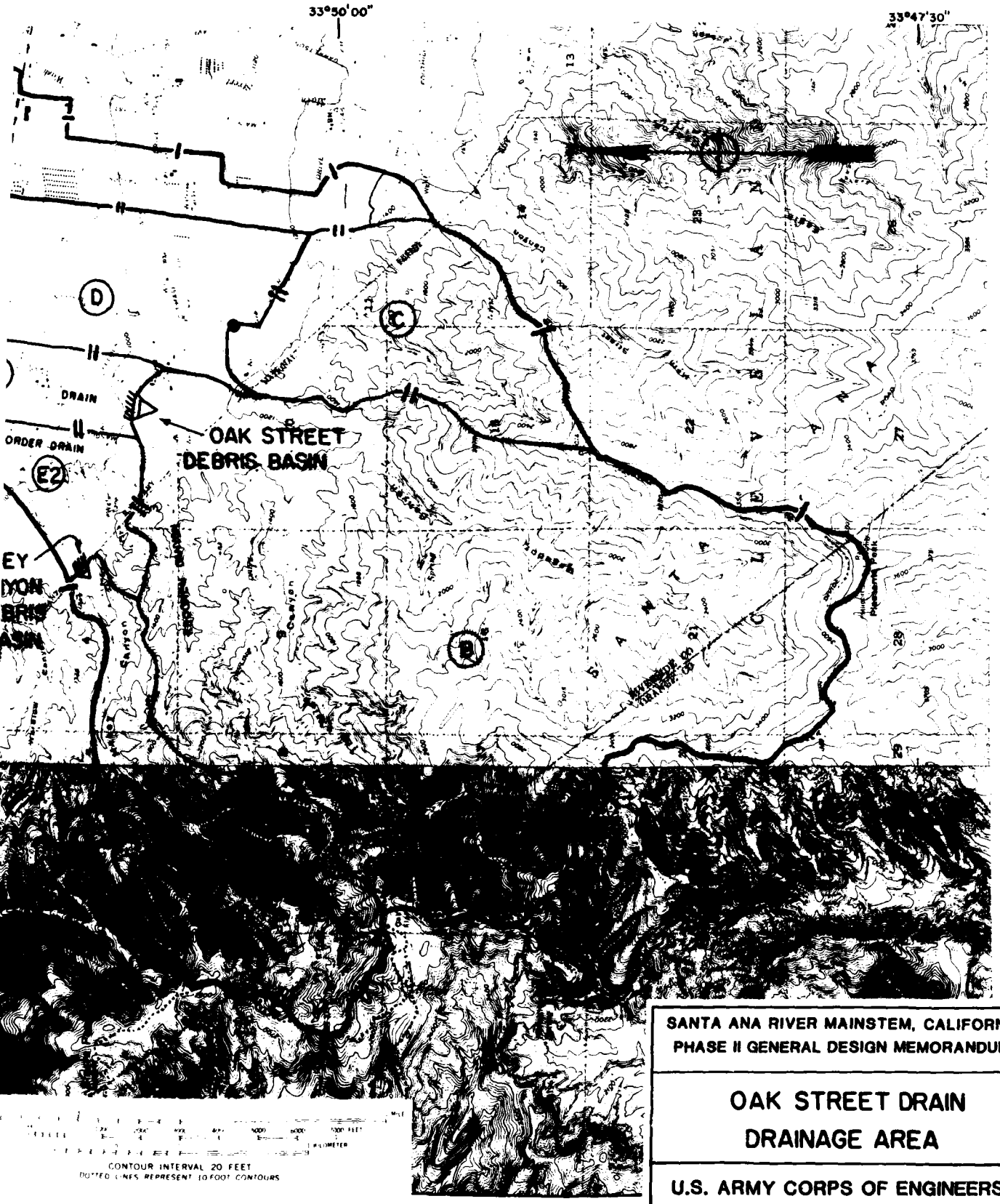
3-03 The 100-year design flood peak discharges were derived from a local storm Standard Project Flood (SPF) determination and a regional discharge-frequency analysis. The 100-year hydrographs were determined

to be a ratio of the SPF. This ratio was established from the regional discharge-frequency analysis. The individual subarea hydrographs were routed and combined to each downstream concentration point. The 100-year design flood peak discharges, with project, for future conditions are presented in table III-1 and are shown in figure 8.

Table III-1. 100-Year Design Flood Peak Discharges.

Concentration Point	Subarea Names	Drainage Area Contributed (sq. mi.)	Peak Discharges (cfs)
Oak Street Debris Basin	B	6.13	4,300
Oak Street Drain Before Confluence with Proposed Lincoln Diversion	B, E_1	6.76	4,600
Mountain Subarea	C	1.24	1,400
End of Proposed Lincoln Ave. Diversion	C, D	2.51	2,400
Confluence of Oak Street Drain and Lincoln Ave. Diversion	B, C, D, E_1	9.27	6,100
Mabey Canyon Debris	A	1.50	1,200
End of Mangular Border Drain	A, E_2	2.12	1,700
Confluence of Oak Street Drain and Mangular Border Drain	A, B, C, D, E_1, E_2	11.39	7,100
Riverside Freeway	A, B, C, D, E_1, E_2, E_3, E_4	11.80	7,100
Oak Street Drain Before Confluence with Main Street Drain	A, B, C, D, E_1, E_2, E_3 E_4, F	11.95	7,100
Main Street Drain	G	2.97	2,900
Confluence of Main Street Drain and Oak Street Drain	A, B, C, D E_1, E_2, E_3, E_4, F, G	14.92	8,000


MAIN STREET DRAIN
33°52'30"
33°50'00"
117°35'00"
117°35'30"
OAK STREET
DRAIN
TRIANGULAR BORDER DRAIN
OAK STREET DEBRIS BASIN
MABEY CANYON DEBRIS BASIN
SANTA FE RAILROAD
FRESNO
TOPEKA
RIVERSIDE
CORONA MUNICIPAL AIRPORT
(YORBA)
SIERRA
LEGEND
BOUNDARY OF DRAINAGE AREA
BOUNDARY OF SUBAREAS.
SUBAREA DESIGNATION.
DEBRIS BASIN.
CONCENTRATION POINT
LOS ANGELES CO.
San Bernardino
SAN BERNARDINO CO.
Los Angeles
Corona
Santa Ana
RIVERSIDE CO.
ORANGE CO.
PACIFIC OCEAN
SAN DIEGO CO.
N
VICINITY MAP
AREA COVERED BY MAP
SCALE IN MILES
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS



SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
DRAINAGE AREA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 7

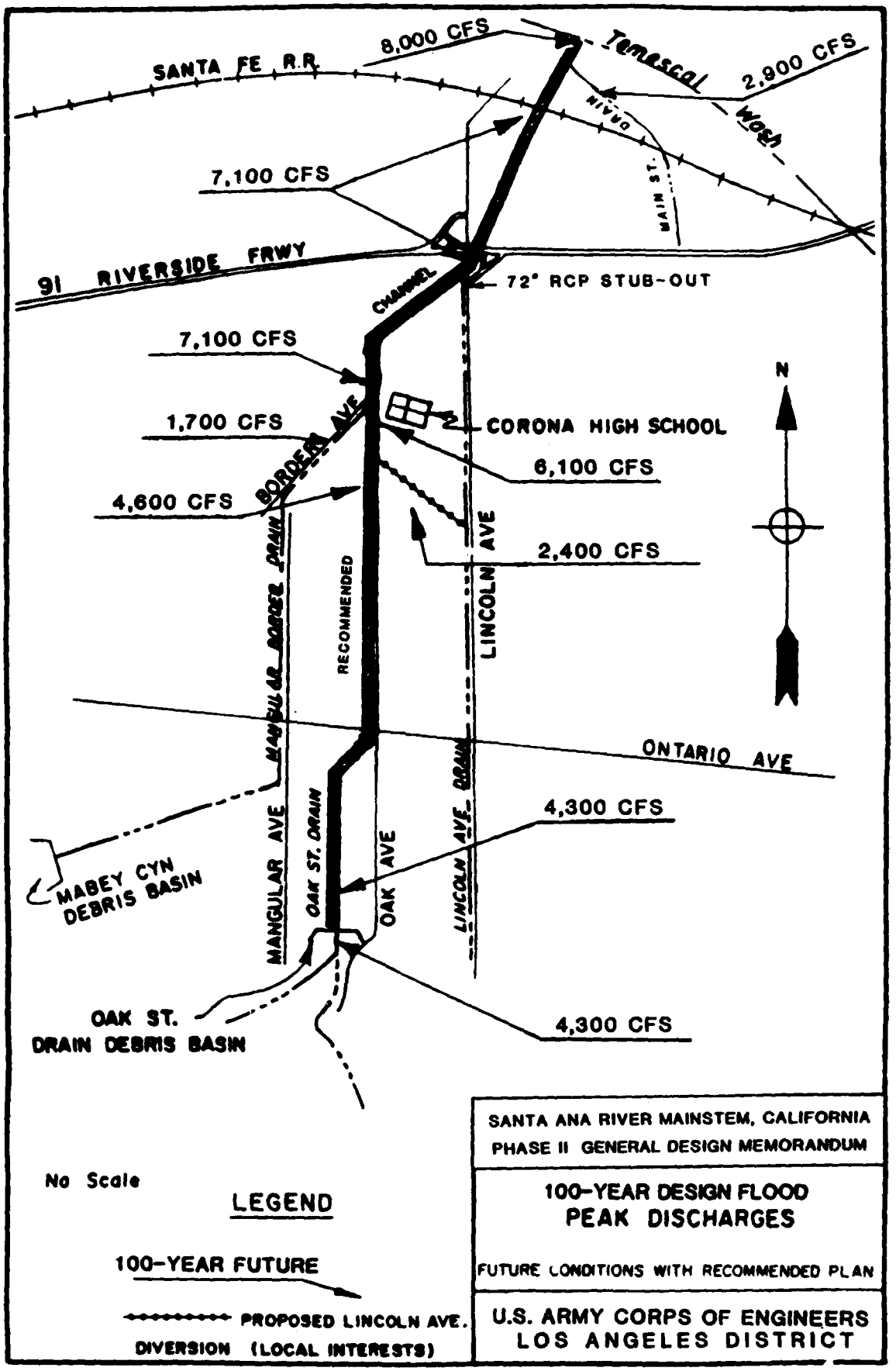

SANTA FE R.R.
8,000 CFS
Temescal Wash
2,900 CFS
MAIN ST.
7,100 CFS
91 RIVERSIDE FRWY
72" RCP STUB-OUT
CHANNEL
7,100 CFS
1,700 CFS
BORDER AVE
CORONA HIGH SCHOOL
6,100 CFS
4,600 CFS
MANGULAR AVE BORDER AVE DRAIN
RECOMMENDED
LINCOLN AVE
2,400 CFS
N
ONTARIO AVE
4,300 CFS
MABEY CYN DEBRIS BASIN
MANGULAR AVE
OAK ST. DRAIN
OAK AVE
LINCOLN AVE. DRAIN
OAK ST. DRAIN DEBRIS BASIN
4,300 CFS
No Scale
LEGEND
100-YEAR FUTURE
PROPOSED LINCOLN AVE. DIVERSION (LOCAL INTERESTS)
SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
100-YEAR DESIGN FLOOD PEAK DISCHARGES
FUTURE CONDITIONS WITH RECOMMENDED PLAN
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 8

IV. HYDRAULIC DESIGN

General

4-01 The hydraulic design of the proposed channel improvements is based on criteria as set forth in EM 1110-2-1601, "Hydraulic Design of Flood Control Channels", July 1970. Design details are presented herein for the Oak Street Drain channel improvements. The proposed project will utilize the existing Riverside County debris basin (pl. 2) for sediment storage. The project will be a channel improvement designed to accommodate the 100-year frequency flood. Hydraulic plan and profile drawings are presented on plates 3 through 16.

Debris Basin

4-02 The existing debris basin, constructed by Riverside County Flood Control District in 1979, will be the inlet structure for the proposed channel. The channel will join the existing spillway chute downstream from the embankment. The present debris basin consists of a compacted earth embankment, an excavated basin, a rectangular concrete broad-crested spillway with stilling basin, and a pool drain.

4-03 The basin provides 253 acre-feet of debris storage, based on a debris slope of one-half the average slope of the existing streambed slope, projected upstream from the spillway crest. The estimated debris-storage requirement is 224 acre-feet for the 100-year frequency event. (See volume 7 of this report for debris production calculations.) With the adequate debris storage, the design floodflows entering the proposed downstream channel will be free of large size sediment.

4-04 The existing spillway structure is a concrete rectangular section 120 feet wide and 24 feet high. The spillway has a 103-foot-long rectangular chute extending just downstream from the basin embankment. The upstream end from the proposed channel improvement will be at station 205+34.58. A rectangular transition 900 feet long will be

provided from the existing spillway chute to the channel. The base width of the transition will decrease from 120 to 30 feet with each wall converging on a 1:20 ratio. At the design discharge of 4,300 ft^3/s, the depth of flow would range from 3.5 feet at spillway crest to 5.0 feet at the downstream end of the transition at station 196+34.58. Velocities will range from 9 ft/sec to 37.5 ft/s in this reach. Using critical depth control at the spillway crest and the calculated water surface upstream, the maximum spillway flow with the water surface at top of embankment would be 15,000 ft^3/s. The spillway chute wall heights will be extended 200 feet (from sta. 205+34.58 to sta. 203+34.58) downstream from the toe of the embankment to convey spillway flow capacity from the basin. Top of the chute channel walls are set for spillway flow capacity discharge estimated to be 15,000 ft^3/s plus a minimum freeboard of 3 feet.

4-05 The total head on the spillway is 5.1 feet for the design discharge of 4,300 ft^3/s. The water surface profile is shown on plate 2. The Standard Project Flood (SPF) discharge is 6,500 ft^3/s and the Probable Maximum Flood (PMF) is 16,000 ft^3/s.

Channels

EXISTING CHANNEL

4-06 The existing Oak Street Drain from the debris basin to the confluence with Temescal Wash is a well-defined channel that has been partly improved by the Riverside County Flood Control District. The channel has pipe and wire fencing for streambank protection in the upstream reach, a concrete channel within the City of Corona, and a trapezoidal earth channel in the lowlands downstream from the Atchison Topeka and Santa Fe (AT&SF) railroad bridge. The gradient of the stream varies from 0.030 at the upstream reach just below the debris basin to 0.001 at the outlet into Temescal Wash Channel. As the stream gradient decreases, the existing channel top width increases from 18 feet below the debris basin to about 90 feet at the outlet into Temescal Wash.

CHANNEL ALIGNMENT

4-07 In general, the alignment of the proposed channel will be along the existing wash with two exceptions:

a. A 2,000-foot long reach just upstream from the Riverside (91) Freeway culvert and;

b. A 2,000-foot reach between the AT&SF railroad bridge and the Temescal Wash confluence.

4-08 All rights-of-way will be provided by local interests. Only minor changes to the alignment, presented in Phase I General Design Memorandum dated September 1980, were made in order to clear property lines or

existing structures. All alignment revisions were coordinated with local interests. Symmetrical spiral transitions will be used upstream and downstream from all curves except:

a. Where the simple curve radius is large (4000 feet or greater) and computed superelevation is less than 0.5 foot, in which case only a simple curve will be used and;

b. Where the deflection angle is less than 2 degrees, in which case an angle point will be used in lieu of a curve in the alignment. This deflection angle is less than a 1 to 20 flare allowed for a rapid flow transition.

4-09 In the project reach, there are 19 curves with deflection angles ranging from less than 4 degrees to almost 61 degrees. The radii of the curves range from 400 to 4,000 feet.

PROPOSED CHANNEL

4-10 The proposed project will provide an entrenched rectangular channel 3-1/2 miles in length from the debris basin spillway to a point 500 feet downstream from the railroad bridge, and a leveed channel, 1/2 mile in length in the lowland next to the water treatment ponds at the downstream outlet. The channel is designed to convey the 100-year flood design discharge varying from 4,300 ft^3/s at the debris basin to 8,000 ft^3/s at the Temescal Wash confluence. The type and size of channel cross sections were selected after giving consideration to maintaining existing street grades, keeping the channel entrenched to collect surface flows, minimizing excavation, utilizing the most efficient hydraulic section, and using existing rights-of-way. The invert grades were designed to maintain stable flow and to minimize interference with existing structures such as bridges and utility lines in order to reduce relocation cost and interruption of service. The flow regime is supercritical from the critical depth control at the debris basin spillway (sta. 206+94.58) to the hydraulic jump, subcritical downstream of the jump to critical depth control at station 20+00, and supercritical downstream to the Temescal Wash Confluence at station 17+30.

CONCRETE-LINED CHANNEL

4-11 The channel will have a concrete rectangular section between the debris basin and the AT&SF railroad bridge. In this reach the steep invert grades, varying from 0.0378 feet/foot to 0.0145 feet/foot, will produce design velocities ranging from 44 to 28 ft/sec. All channel invert slopes were selected to preclude unstable flow conditions where depth of flow is within stable limits $1.1\ D_c < D < 0.9\ D_c$. The channel base widths will vary from 18 to 30 feet and wall heights from 4.0 to 18 feet. (See table IV-1.)

Table IV-1. Summary of Hydraulic Design Data.

Station	b (feet)	Side Slope Z	Inv. Slope (feet/foot)	Control Elevation (feet)	Cross Section	Lining
Debris Basin Spillway Crest						
206+39.58	120	0		1022.00	Rect.	Conc.
			.22857			
205+34.58	120	0		998.00	"	"
			.03000			
202+34.58	--	0		980.00	"	"
			.032327			
196+34.58	30	0		---	"	"
			.032327			
194+14.84	30	0		962.5	"	"
			.034976			
192+60	30	0		957.08	"	"
			.034976			
186+00	30	0		934.00	"	"
			.028540			
183+00	18	0		---	"	"
			.028540			
171+60	18	0		891.70	"	"
			.029613			
163+00	18	0		867.50	"	"
			.037800			
158+70.64	18			851.27	"	"
			.026613			
143+00	18			809.47	"	"
			.021380			
138+80	18			800.49	"	"
			.02581			
131+00	18			780.35	"	"
			.027236			
124+96.01	18			763.90	"	"
			.024370			
124+15.15	18				"	"
			.024370			
Lincoln Avenue Channel Confluence						
122+29.01	24				"	"
			.024370			
118+20	24				"	"
			.024370			
117+70	26				"	"
			.024370			
113+21.13	26				"	"
			.024370			
Mangular Channel Confluence						
111+90.12	26				"	"
			.024370			
103+00	26	0			"	"

Table IV-1. (Continued)

Station	b (feet)	Side Slope Z	Inv. Slope (feet/foot)	Control Elevation (feet)	Cross Section	Lining
102+00	24	0		707.95	Rect.	Conc.
			.02350			
88+00	24	0		675.05	"	"
			.03850			
87+00	24	0		671.2	"	"
*			.022675			
80+50	24	0			"	"
			.022675			
80+10	28	0			"	"
			.022675			
79+00	2x13.5	0			Dbl Box	"
			.022675			
67+70	24	0			"	"
			.022675			
67+30	24	0			"	"
			.022675			
65+70	24	0			"	"
			.022675			
65+30	20	0			"	"
			.022675			
63+00	20	0		618.07	Rect.	"
			.014526			
57+10	20			609.50	"	"
			.02124			
45+00	20			583.80	"	"
			.024750			
37+00	20	0		564.00	"	"
			.00100			
36+00	28	2			Trap	Grouted Stone
			.00100			
31+00	28	2			"	"
			.00100			
30+00	20	2			"	"
			.00100			
29+00	20	2			"	"
Main Street Drain Confluence						
27+00	30					
25+00	30	2			Trap	Grouted Stone
			.0010			
20+00	30	2		562.3	"	"
			.01920			
17+80	30	2		558.08	"	"
			.060			
17+30	30	2		555.08	"	"
Temescal Wash						

*Sta. 86+46.08 (ahead) = Sta. 85+89.21 (back).

TRANSITION FROM RAPID TO TRANQUIL FLOW

4-12 A roughness control transition will be provided downstream from the AT&SF railroad bridge to transform rapid flow in the rectangular channel to tranquil flow in the downstream trapazoidal channel without an abrupt hydraulic jump. The design is based on design procedures outlined in EM 1110-2-1601 (pages 53 through 56, and pls. 46 and 47). A high-velocity jet from the rectangular channel will be expanded in the transition by means of lateral and boundary surface roughness control so that a gradual flow change involving a weak-type hydraulic jump will occur in the channel just downstream from the transition. The transition will be 100 feet long with base widths varying from 20 feet in the rectangular channel section to 28 feet in the trapezoidal channel. The reach from station 35+00 to station 20+00 will have a grouted rock invert and side slopes to dissipate turbulent flows. The invert from station 35+00 to station 31+00 will consist of a 36-inch rock layer with the bottom 27 inches grouted and 9 inches of ungrouted rock projecting. The roughness (9-inch projections) in this reach was determined using a Mannings "n" value of of 0.030 which corresponds to an equivalent roughness, k value of 0.7 feet. The k value was determined from plate 4 of EM 1110-2-1601. The side slopes of the downstream channel from the grade change at station 37+00 to Sta. 20+00 will have 15 inches of grouted rock using normal construction methods.

4-13 To ensure a weak jump in the basin, a row of dentates will be provided at Sta. 34+45 to trigger the design jump. (A row of five dentates 2.0 feet wide, 2.0 feet long, and 2.0 feet high will be set on a 6-foot wide concrete invert slab at sta. 34+45.) To submerge the jump, a concrete outlet will be constructed with critical control at station 20+00 to develop the necessary backwater depths in the basin.

REVETMENT ON SIDE SLOPES

4-14 The channel in the lower reach will be a trapezoidal channel with a base width varying from 20 feet to 30 feet and will have 1 vertical on 2 horizontal side slopes. The side slopes and invert will be lined with grouted stone or concrete. The wall heights will range from 12.5 feet to 18.0 feet above the channel invert. The levee embankment will be 9 to 12 feet above the ground in the water treatment ponding area between station 38+00 and the Temescal Wash confluence. A concrete channel will be provided for the outlet to clear a 30-inch sewer line and accelerate flows into the concrete approach channel proposed for Temescal Wash just upstream of Lincoln Avenue bridge. If the approach channel at Temescal Wash is not improved at time of construction, a 5-foot deep cutoff wall and a 100-foot long grouted stone apron will be provided to control scour.

WATER-SURFACE COMPUTATIONS

4-15 The water surface profiles were computed by the reach method using the Mannings Formula. Computer program WASURO, developed by the Los Angeles District was used to calculate the friction losses for the water

surface profiles. For high velocity flows WASURO automatically includes air entrainment. The air entrainment curve shown on plate 45a of EM 1110-2-1601 was converted into equations. For Froude numbers less than or equal to 8.2, the equation is:

$$\frac{Da}{D} = 0.906\ (e)^{\ 0.0615F}$$

Where: D_a = depth with air
D = depth without air
e = a constant = 2.7183
F = Froude number

The "n" values used were 0.030 for grouted stone reaches and 0.014 for the concrete-lined reaches to compute the water surface for the wall heights. The break in the grade from steep to mild slopes downstream from the railroad bridge will change flow from rapid to tranquil state in the form of a weak hydraulic jump. The location of the jump was determined by making backwater computations from upstream and downstream control points. The hydraulic jump will occur at Sta. 34+45, where the rapid flows sequent depth is submerged by the down-stream water surface. The weak hydraulic jump with Froude number of 2.1 will produce a series of small rollers on the surface of the jump and a smooth downstream water surface. The velocity throughout the jump will be fairly uniform and the energy loss low.

4-16 Transition losses were computed using the warped-section loss coefficient of 0.10 for contraction and 0.20 for expansion (page 26, EM 1110-2-1601). Manning's "n" value of 0.014 was used to compute flow depths in the concrete channel. The use of a Manning's "n" value of 0.014 allows for an increase in channel roughness which results from typical channel weathering. Hence, channel wall heights were determined from computed water surface based on the 0.014 roughness value. According to plate 4 of EM 1110-2-1601, an "n" value of 0.014 corresponds to a surface roughness "k" of about 0.002 which is within the 0.0015 to 0.0100 range for "k" values for a concrete finish shown in Table 8-1 of Chow's Open Channel Hydraulics. Oak Street Drain will be constructed using metal forms and steel trowel joints. Hydraulic Design Criteria, (sheets G31 to G31-2), recommends an average "k" value of 0.002 for a field channel with a smooth, steel troweled, concrete finish. It is recognized that the final judgement as to typical channel weathering, should be based on local conditions. The Los Angeles District office in 1966, with the assistance of the U.S. Geological Survey, conducted a prototype test to determine the channel roughness on the Tujunga Wash Channel, a rectangular concrete channel constructed in 1952. The prototype test "n" values determined ranged from 0.0114 to 0.012. Based on plate 4 of EM, these "n" values would correspond to apparent roughness "k" values of 0.0006 to 0.00010 feet. Therefore, the use of "k" equal to 0.002 for smoother concrete is appropriate.

4-17 In conformance with the requirements of EM 1110-2-1601, the energy dissipator between stataion 20+00 and station 37+00 has been analyzed using two sets of "n" values: 0.012 for concrete with a corresponding "n" of 0.025 for grouted stone; and 0.014 for concrete and with a corresponding "n" of 0.030 for grouted stone. The length of jump was determined for each case using plate 46 in EM 1110-2-1601 and the location fixed using USBR Monograph No. 25, page 12. For the smoother "n" value the jump occurs at station 32+65 and is 62 feet long, and for the rougher "n" value the jump is located at station 34+45 and is 68 feet long. In the first case the pre-jump Froude Number is 1.95, and the in the second case the Froude Number is 2.15. A hydraulic jump with a Froude Number from 1.7 to 2.5 is classified as a weak jump and according to Monograph No. 25 page 16 "there is no particular stilling basin problem involved." There is critical depth control at station 20+00 which fixes the tailwater depth and stabilizes the location of the jump. As discharges decrease below the design value the jump moves upstream with lower depths and the Froude Numbers tend to increase.

FREEBOARD

4-18 A minimum freeboard of 2.0 feet was set in the rectangular sections, 2.5 feet minimum in the trapezoidal reach, and a minimum 3 feet for levees, confluences and bridges.

BRIDGES AND CULVERTS

4-19 All bridges will be redesigned for modification by the local interests with clear-spans and a minimum freeboard allowance of 3 feet.

COVERED SECTIONS

4-20 Between station 79+00 and station 65+40 a box section 1360 feet long is required to convey flows under the Riverside Freeway (State Highway 91) and existing adjacent development south of the freeway. The culvert will be a rectangular concrete double box (each barrel 13.5 foot wide) from station 79+00 to station 67+70 (the divided channel is required to minimize superelevation in the curved portion) and 24 foot wide clear span from station 67+70 to station 65+40. The divided channel will extend 100 feet upstream of the covered section and have a pier nose extension to minimize debris accumulation on the pier. Openings 1 foot wide by 2 feet high in the divider wall will be provided every 300 feet to equalize differential pressure buildup between barrels and to minimize superelevation. The 400-foot radius curve between station 68+32 and station 71+08 will have a spiral transition upstream and downstream of the simple curve and both barrels will be banked. Open channel rapid flow conditions will be maintained throughout the culvert.

SUPERELEVATIONS

4-21 Superelevations at curves were determined by methods outlined in EM 1110-2-1601. Superelevations were calculated using the formula:

$$y = C\frac{V^2W}{gr}$$

where

y = rise in water surface between a theoretical level water surface at the center line and outside water-surface elevation (superelevation)
C = coefficient (see note below)
V = mean channel velocity
W = channel width at elevation of center-line water surface
g = acceleration of gravity
r = radius of channel center-line curvature

The coefficient "C" used is 0.5 for rapid flow in a rectangular channel with spiral transitions.

The proposed channel will have rapid flow conditions with spiral transitions upstream and downstream of all simple curves except as stated in section 4-08b. Spiral transitions are used to minimize wave disturbances caused by curves in channel alignment.

4-22 For rectangular channels the invert is banked by rotating the bottom in transverse sections about the centerline of the channel invert. Spirals are used upstream and downstream of the central curve with banking being accomplished over the length of the spiral. Wall heights are equal on both sides of the banked curves and allowance for superelevation around the curve is made by banking the invert. There are a total of 19 curves in the channel alignment with superelevations ranging from 0.2 feet to 1.7 feet. Superelevations were pivoted about the centerline of the channel for ease of construction so that the centerline of the channel will be a constant slope along the length of the curve. In addition, since the slope of the channel is 2 percent or more, there will be no "stagnant pools of water." All superelevated reaches will drain.

TRANSITIONS

4-23 The channel was designed using straight-line transitions to confine flow disturbances within the normal channel freeboard allowance. The wall flare for each wall, (horizontal to longitudinal), conforms to the recommended 1:20 ratio for velocities over 30 ft/s.

Confluences

GENERAL

4-24 Confluences were designed using the following criteria set forth in EM 1110-2-1601:

a. The design water surface elevations in the two joining channels should be approximately equal at the upstream end of the confluence.

b. The angle of junction intersection should be as small as possible but in no case greater than 12 degrees.

c. Proper expansion of the main channel width below the junction should be provided.

d. Rapid flow depths should not exceed 90 percent of the critical depth.

4-25 In the design of each confluence, two combinations of flow were considered:

a. Peak 100-year discharge in the main channel and the corresponding contemporaneous discharge in the side channel.

b. Peak 100-year discharge in the side channel and the corresponding contemporaneous discharge in the main channel.

4-26 The momentum equation was used to determine the highest water surface in the main channel for each of the above cases to set the wall heights for the worst case. A 3-foot minimum freeboard was provided at confluences to account for waves and turbulence. At the rapid flow junctions (Lincoln Avenue Drain and Mangular Channel) the highest water surface downstream of the junction occurred for peak flow in the side channel. Wall heights for several hundred feet downstream of the junctions are set for peak flow in the side channel.

LINCOLN AVENUE CONFLUENCE

4-27 The Lincoln Avenue Drain confluence intersects Oak Street Drain about 1,800 feet upstream from 10th Street. (Oak Street Drain width upstream from the confluence is 18 feet and increases to 24 feet downstream.) The two channels intersect at an angle of 4 degrees. The junction was designed using the momentum principle for above-mentioned combinations of contemporaneous discharge conditions. The highest water surface upstream from the confluence was caused by the peak discharge in Oak Street Drain and the contemporaneous discharge in Lincoln Avenue channel. The highest water surface downstream from the confluence was caused by the peak discharge in Lincoln Avenue Drain and the contemporaneous discharge in Oak Street Drain (the affect extends about 1,000 feet downstream from the confluence). Three feet of freeboard was added to the above water surfaces to set wall heights at the confluence. For the condition of peak discharge in Oak Street Drain and contemporaneous discharge in Lincoln Avenue Drain the upstream water surfaces are within 0.4 feet.

4-28 The Lincoln Avenue Channel will be improved by local interests and will have a capacity of 2,400 ft^3/s. A 10-foot-wide rectangular reinforced concrete confluence side channel and an inlet transition for the existing earth channel will be provided.

MANGULAR CONFLUENCE

4-29 Mangular Channel is an existing 18-foot wide rectangular concrete channel that joins Oak Street Drain at a curve approximately 750 feet upstream of 10th Street.

4-30 To facilitate Oak Street Drain flows around the 461-foot-long circular curve at the confluence, a shelf type junction structure will be provided. Mangular Channel outlet invert will have a 120-foot-long overflow spillway 4.7 feet above the Oak Street Drain invert. The structure will enable Oak Street Drain floodflows to turn, at a depth of 5.2 feet, around the curve, and the discharge from Mangular Channel will commingle parallel to Oak Street Drain. The proposed structure is similar to the confluence of Burbank-Western and Stough Canyon confluence within the Los Angeles County Drainage Area that has been checked by a hydraulic model and constructed in Los Angeles County. Both the prototype and the models have performed satisfactorily. To contain any possible secondary flows that may develop in the channel, 4 feet of freeboard will be provided 1,000 feet downstream of the structure; and 3 feet for an additional 500 feet downstream.

MAIN STREET DRAIN CONFLUENCE

4-31 The Main Street Drain interesects Oak Street Drain approximately 1,200 feet downstream from the AT&SF railroad bridge. The confluence was designed for the highest water surface resulting from a combination of contemporaneous discharges. In this case the highest water surface upstream of the confluence occurred from the peak flow in the side channel.

TEMESCAL WASH CONFLUENCE

4-32 Oak Street Drain discharges into Temescal Wash approximately 300 feet upstream of Lincoln Avenue. The City of Corona has constructed a rapid flow concrete trapezoidal channel and a new bridge for Lincoln Avenue. The proposed channel and bridge will have a capacity for the 100 year discharge of 33,000 ft^3/s at a water surface elevation of 568 at the confluence. The Oak Street Drain channel from station 20+00 to the Temesical Wash confluence will be a rapid flow trapezoidal concrete channel section to be compatible with the City design. From station 20+00 to station 31+00 the channel is designed for tranquil flow conditions and will be lined with grouted stone. Temescal Wash downstream of Lincoln Avenue will remain natural.

Sediment

4-33 Sediment not trapped by the Oak Street Debris Basin will be of small size and readily flushed through the improved channel with high velocities ranging from 9 to 42 ft/s. Sediment contributed by Mangular, Lincoln Avneue, and Main Street Channels will be insignificant and small size suspended load since the watersheds are urbanized and controlled by debris basins.

Side Drainage

4-34 Side drainage requirements would consist of (1) extending or replacing existing drains, and (2) accommodating the future drainage structures proposed by local interests. The improved Oak Street Drain Channel will be fully entrenched except for the 2,000 feet at the downstream end. Hence, side drainage can enter the channel either through locally provided storm drains or over the top of the channel walls without ponding.

4-35 The general slope of the adjacent land mass follows the gradient of the drain. Excess runoff not collected by the local storm drainage system will travel downstream and eventually be collected by crossing streets, bridge embankments and existing drainage depressions, and flow into the channel over its walls. The tops of the levees will be above the surrounding ground for the reach of channel between station 34+00 and the Temescal Wash confluence (approximately 2,000 feet). The drainage area tributary to this reach (5 acres) is bounded by the Temescal Wash and Oak Street Drain confluence on the north, Lincoln Avenue on the west and the existing alignment of Oak Street Drain (to be abandoned) on the south. A flap gated 27-inch-diameter reinforced concrete pipe (RCP) will be provided to accommodate an estimated 10 ft^3/s discharge. This area will be maintained as percolation ponds. The entrenched nature of the channel together with the system of side drains will preclude ponding.

4-36 Sheet flow can be expected over the tops of the channel walls, but will be reduced when the adjacent area has been developed and a complete storm drain system has been constructed. The county's master drainage plan has been incorporated into the side drainage (table IV-2).

INVERT ACCESS RAMP

4-37 An access ramp would be provided along the channel at channel station 91+40. A typical access structure would be a 15-foot-wide ramp entering the channel at 90 degrees. The downstream corner wall would have splash guards.

Residual Overflow with Proposed Channel

4-38 The proposed channel is designed to convey the 100-year discharge throughout its length, and the existing Riverside County Flood Control and Water Conservation basin will trap the floodflow sediment. When floods exceed the design discharge, Oak Street Drain flows will overtop the channel walls and flow in the adjacent streets. Residual overflow limits for the SPF event were delineated using normal depth calculations, together with historical flooding data, and Flood Insurance Rate Maps to set overflow limits. The calculations for the SPF floodflows is for the flows exceeding the design condition and do not include channel freeboard. Residual SPF flows from the debris basin overtop the entrenched channel downstream of the spillway and generally follow the

channel alignment upstream from the Mangular Channel confluence and inundate the floodplain downstream to Temescal Wash. Residual overflow limits and depths of flooding are less severe than the existing condition. The SPF residual overflow is shown in figure 9.

Table IV-2. Pertinent Information on Side-Drainage Investigation, Oak Street Drain (Right Bank).

Subarea			Side-Drainage Requirements					
Drain No.*	Size Mi^2	Discharge Peak** ft^3/s	Existing Capacity Q ft^3/s	Description Existing	Description Proposed	Station	Remarks	Disposition of Excess Flow
1	0.004	4	8	18" RCP	---	204+30	Connect to existing drain.	
3	0.09	72	55	36" CMP	5-C***	169+00	Connect to existing drain.	
4	0.003	2.5	4.5	12" CMP	---	161+70	Connect to existing drain.	
7	0.002	2	3	8" PVC	---	161+30	Connect to existing drain.	
9	0.04	45	100	36" RCP	---	138+50	Connect to existing drain.	
11	2.51	2400	0	---	Lincoln Diversion Line 3	124+00 to 122+30	Provide confluence for 10' wide rect. concrete channel.	Excess flow will enter Lincoln Div. Line 3.
12	0.07	60	55	60" RCP	---	117+50	Connect to existing drain.	
14	0.01	9	15	18" RCP	---	106+30	Connect to existing drain.	
17	0.03	22	22	Street drain	---	85+00	Provide inlet for Street flow.	
18	0.01	8	8	Concrete swale	---	80+00	Provide inlet for Street flow.	

Table IV-2. (Continued)

Subarea			Side-Drainage Requirements					
Drain No.*	Size Mi^2	Discharge Peak** ft^3/s	Existing Capacity Q ft^3/s	Description Existing	Description Proposed	Station	Remarks	Disposition of Excess Flow
19	0.019	20	20	---	30" RCP	78+30	Provide inlet for surface flow.	
20	0.15	170	168	72" RCP	Line 8***	73+73	Connect to existing drain.	Excess flow will enter channel over top of wall.
25	0.005	4	10	12"square RC conduit	---	41+50	Connect to existing drain.	

*Location of side drains is shown on the plan view of plates 3 through 17.
**25-year peak discharge for all side drains except 100-year peak discharge for Lincoln Avenue Channel.
***Proposed by the City of Corona.

Table IV-2a. Pertinent Information on Side-Drainage Investigation, Oak Street Drain (Left Bank).

Subarea			Side-Drainage Requirements					
Drain No.*	Size Mi^2	Discharge Peak** ft^3/s	Existing Capacity Q ft^3/s	Description Existing	Description Proposed	Station	Remarks	Disposition of Excess Flow
2	0.004	4.0	8	18" RCP	---	204+30	Connect to existing drain.	
5	0.03	25	9	8" CI		161+70	Connect to existing drain	
6	0.08	60	62		5-B***	161+50	Provide stub for 33" RCP.	
8	0.003	2.5	.9	8" PVC		161+30		
10	0.10	80	160	-	5-A***	130+20	Provide stub for 60" RCP.	
13	2.12	1700	1700	18' Wide rectangular	18' Wide channel	112+06	Mangular Channel	
15	0.11	88	8	12" CMP	42" RCP	90+60	Connect to existing drain and provide stub for 42" RCP.	
16	0.004	4	8	12" CMP	---	90+60	Connect to existing drain.	
21	0.040	40	50	---	48" RCP	65+80	Provide for existing drain.	
22	0.006	5	15	18" CMP	---	61+00	Connect to existing drain.	
23	0.008	7	20	Grate in bridge deck	Catch basin	60+00	Provide stub form.	

Table IV-2a. (Continued)

Subarea			Side-Drainage Requirements					
Drain No.*	Size Mi^2	Discharge Peak** ft^3/s	Existing Capacity Q ft^3/s	Description Existing	Description Proposed	Station	Remarks	Disposition of Excess Flow
24	0.003	3	20	Grate in bridge deck	Catch basin	59+75	Provide stub form.	
26	0.040	30			5-E***	40+70	Provide stub in trap ch.	
27	0.037	28	10	None	27" RCP	16+00 levee.	Provide gated outlet.	

*Location of side drains is shown on the plan view of plates 3 through 17.
**25-year peak discharge for all side drains except 100-year peak discharge for Lincoln Avenue Channel.
***Proposed by the City of Corona.

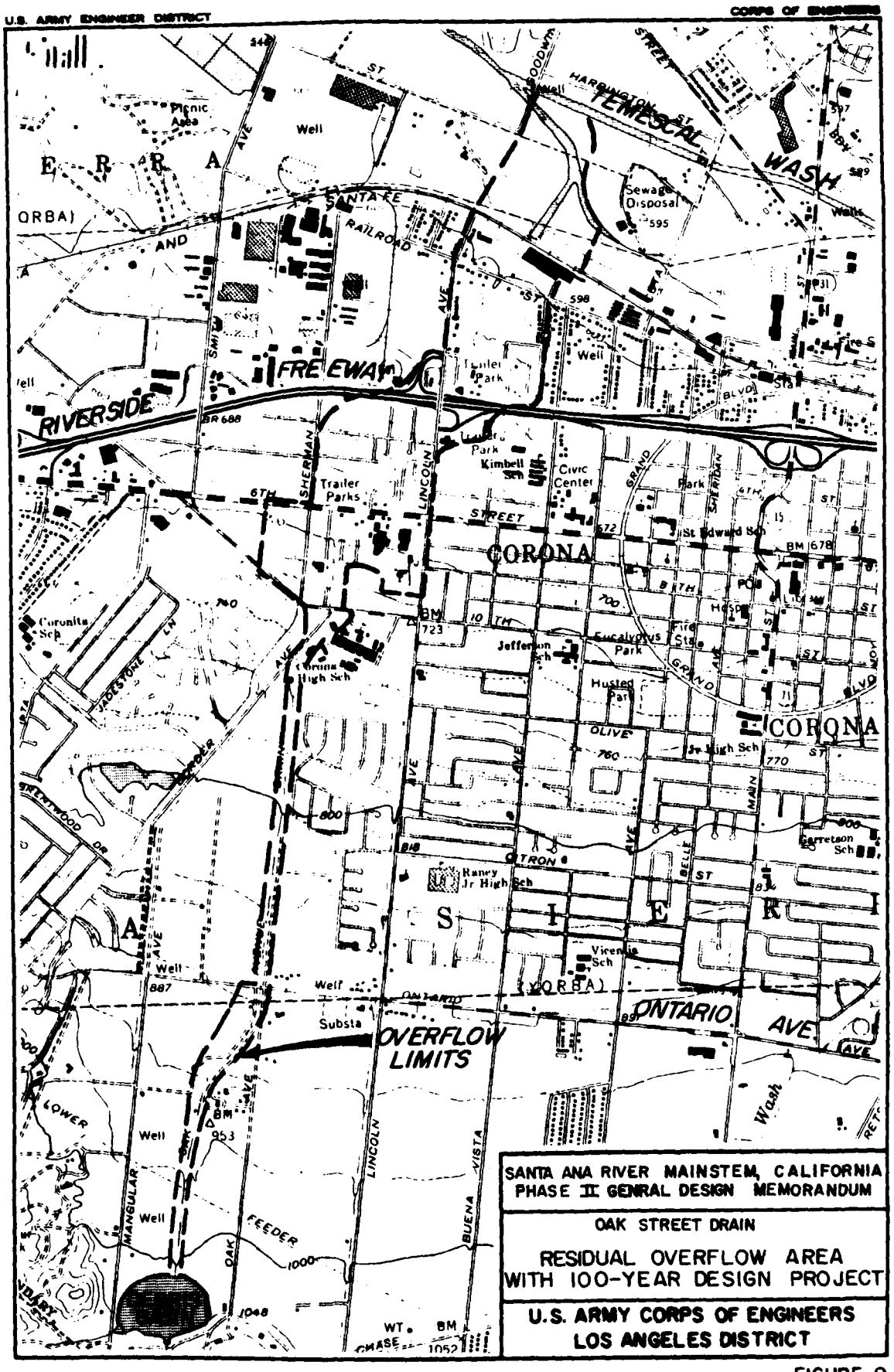

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
TEMESCAL WASH
SANTA FE RAILROAD
FREEWAY
RIVERSIDE
CORONA
Civic Center
Trailer Parks
Picnic Area
Well
Sewage Disposal
Trailer Park
Kimbell Park
Eucalyptus Park
Husted Park
Jefferson Sch
Corona High Sch
Coronita Sch
Garretson Sch
Raney Jr High Sch
Virginia Sch
Substa
ONTARIO AVE
OVERFLOW LIMITS
LOWER
MANGULAR
FEEDER
OAK
LINCOLN
BUENA VISTA
Wash
SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENRAL DESIGN MEMORANDUM
OAK STREET DRAIN
RESIDUAL OVERFLOW AREA
WITH 100-YEAR DESIGN PROJECT
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 9

V. GEOLOGY, SOILS, AND MATERIALS

Regional Geologic Setting

5-01 The Oak Street Drain is located on recent and older alluvial fan deposits in the City of Corona. Two recognized faults occur within the area, the Chino and Elsinore faults. Although the evidence of recent activity on these faults is questionable, a maximum seismic event exceeding Richter magnitude 6.0 could occur on either. However, the probability of this occurrence near the project area is low. Groundwater levels in the project area are typically well below the invert of the proposed channel, except in the reach downstream of station 20+00 near the confluence with the Temescal Wash channel where the potential for shallow groundwater (depths less than 5 feet below invert) exists.

Investigations

5-02 The area was investigated by excavating 18 test trenches and two test holes from 1979 to 1984. In addition, the City of Corona and CALTRANS have conducted test borings at the Sixth and Tenth Street bridges and near the Riverside Freeway, respectively.

Foundation Conditions

5-03 The foundation along the channel, at the railroad bridge, and at the Riverside Freeway consists of alluvial deposits ranging from silty sands to silty gravelly sands. In general the foundation materials are medium dense to very dense. At the railroad bridge, there is a layer of very stiff silt at 23 feet, and soils are generally medium dense. At the freeway, soils range from loose to dense.

Laboratory Testing Results

5-04 Laboratory tests included mechanical analyses, moisture content determination, Atterberg limits, and compaction studies. Based on these tests, soils design values were selected as follows:

	Compacted Fill or Backfill	In-Situ Materials
Dry weight (pcf):	119	114
Moist weight (pcf):	130	124
Saturated Weight (pcf):	137	131
Dir. shear angle (degrees):	38	35
Cohesion (pcf):	0	0
Permeability (ft/day):	1.0	1.0

Construction Consideration

5-05 The allowable bearing capacity for the concrete channel footings would be maximum of 4,000 lbs/ft^2, which would be increased by 33 percent for short durations of seismic loading. Standard excavation methods are adequate for concrete channel section, although dewatering and a subdrainage system would be required below station 40+00. Temporary excavation side slopes should be no steeper than 1V on 075H. Excavated materials are suitable for backfill.

5-06 For leveed and trapezoidal sections, materials will be obtained from the channel excavations. A levee slope of 1V on 2H provides factors of safety for various reaches of from at least 1.04 and 1.7 for earthquake loading and long-term static loading conditions, respectively. Existing levee materials will be removed to the natural subgrade prior to construction of the recommended channel improvements, and levee materials should be graded to eliminate stones larger than 12 inches. Grouted and ungrouted stone will be used to protect the riverside slope and invert of the trapezoid channel. There are several sources of stone suitable for use in channel construction within 25 miles of the project site.

5-07 The natural foundation at the railroad will provide adequate footing for the railroad bridge, with footings founded at least 24 inches below channel invert and a maximum loading of 6,000 lbs/ft^2.

5-08 At the Riverside Freeway, a box conduit is required because soils, with their substantial silt content, cannot be adequately stabilized by grouting and tunneling.

5-09 Concrete materials are available in adequate quantities within 15 miles of the project area. There are a number of suppliers of cementous materials and at least two local sources of aggregate suitable for the concrete sections of the channel.

5-10 Construction of Oak Street Drain would result in a surplus of excavated material of approximately 77,000 cubic yards. This surplus material would be disposed at a county dump located near the intersection of Magnolia Avenue and Highway 15, about 3 miles from the downstream end of the project.

VI. STRUCTURAL DESIGN

General

6-01 This section presents the feature design for the structural elements for the proposed channel. The elements of this project include open rectangular channel, single and double box culverts, transition structures, confluences, and a railroad bridge.

References

6-02 All structures will be designed in accordance with applicable provisions of the following Engineering Manuals for Civil Works and specifications.

Reference	Title
EM 1110-1-2101	Working Stresses for Structural Design
EM 1110-2-2502	Retaining Walls and Flood Walls (Draft Edition)
EM 1110-2-2902	Conduits, Culverts, and Pipes
EM 1110-2-2103	Details of Reinforcement-Hydraulic Structures
ETL 1110-2-312	Strength Design Criteria for Reinforced Hydraulic Structures
American Railway Engineering Association	Manual for Railway Engineering

Unit Stresses

6-03 Unit design stresses which will be used in the design of the proposed structures are given in the following table.

Table VI-1. Unit Design Stresses, Weight and Properties.

CONCRETE

Ultimate Compressive Strength:

Cast-in-place structures other than culverts (box and railroad bridge)	$f'c = 3,000$ psi
Box culverts (including railroad bridge)	$f'c = 4,000$ psi
Modulus of Elasticity	$Ec = 57,000 (f'c)^{1/2}$

REINFORCING STEEL

Grade 40: Yield Strength = 40,000 psi

Grade 60: Yield Strength = 48,000 psi

Modulus of Elasticity = 29,000,000 psi

WEIGHT AND PROPERTIES

Concrete Weight	150 pcf
Water Weight	62.5 pcf

SOIL PROPERTIES

	Backfill	Foundation
Moist weight (pcf)	130	124
Saturated weight (pcf)	137	131
Internal Friction Angle (degree)	38	35
Equivalent Fluid Pressure Coefficient: Active (K_A)	0.24	----
At Rest (K_p)	4.2	----
Allowable Bearing Pressure (psf)	---	4,000

Rectangular Channel, Transition Structures, and Confluences

RECTANGULAR CHANNEL

6-04 The walls of the open rectangular reinforced concrete channel will be designed as L-Type or U-Type retaining walls. For L-Type retaining walls, a 10-inch thick concrete invert will be provided between the wall footings with a center mat of reinforcement consisting of 5/8-inch diameter steel bars at 12 inches on centers in each direction. The walls will be designed in pairs opposite each other with the wall footing abutting the 10-inch thick invert slab. This type of design will provide the necessary resisting force required for stability and will prevent sliding. For U-type retaining walls, the toe of each wall footing will be at the channel centerline.

6-05 Both L-Walls and U-Walls will be designed for two loading conditions: Condition I (channel empty), and Condition II (channel full). For Condition I loading, earth pressure on the back of the wall will be determined in accordance with criteria contained in Civil Works Engineer Letter 64-7, 22 April 1964, Subject: "Construction Stresses in Retaining Walls." The lateral earth pressure due to a condition of drained backfill will be computed. The triangle distribution of the horizontal earth pressure will be assumed in the design of the wall stem and footing. Besides the earth pressure, a maximum loading of 200 psf due to construction equipment will be applied at the top of wall; the loading will be decreased by unit lateral earth pressure Kw for each foot of depth. Friction with a coefficient equal to 3/4 of the tangent of the internal friction angle of the backfill material will be assumed to act on the back of the walls. Straight line distribution of soil pressure would be assumed in the design of wall footing. For Condition II loading, the hydrostatic pressure of 62.5 pounds per square foot on the channel side of the wall will be balanced by the passive lateral earth pressure acting on the back of the wall. Vertical reinforcing steel in the channel face of the wall will consist of either reinforcing bars 1/2-inch in diameter on 2-foot centers or reinforcing bars comprising 10 percent of the vertical steel in the back of the wall, whichever gives the greater area of steel.

TRANSITION STRUCTURES

6-06 Transition structures will be provided where the width of the rectangular section changes along with the height of the wall within certain distances. The structure, will be designed as an open rectangular channel.

CONFLUENCES

6-07 Confluence structures will be formed at Lincoln Avenue Channel and Mangular Channel joining Oak Street Drain. A divider wall at the confluences will be designed for their respective differential water pressure against the wall between the two channels, and will also be designed for seismic loading.

Box Culvert

6-08 The box culvert section will be designed in accordance with EM 1110-2-2902 to carry vertical earth loads, lateral earth pressures, hydrostatic pressures, and live loads. The lateral active pressure on the walls of the channel will be determined by the Rankine theory. The friction due to the earth backfill on the wall will not be considered, and a straight line distribution for foundation pressure will be assumed. The live loads for box culvert under the freeway will be distributed in accordance with AASHTO Standard Specifications for HS 20-44 design loading. Jacking pressures and axial forces due to vertical loads and horizontal earth pressures will be considered in the design. Box culverts under the railroad will be designed according to American Railway Engineers Association.

Side Drain Structures

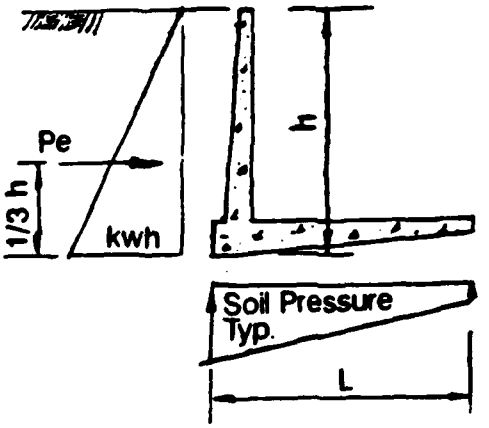
6-09 Appropriate sizes of RCP drainage pipes will be provided to connect existing drainage pipes into proposed channel. Automatic drainage gates will be provided wherever required (see tables IV-2 and 2a).

Railroad Bridge

6-10 The existing Santa Fe Railroad bridge, including its abutments, was designed for Cooper 65 loading. The proposed bridge will be designed as a box culvert for Cooper 85 loading as required by the railroad involved and in accordance with American Railway Engineers Association Manual. The change in loading criteria is not considered a betterment.

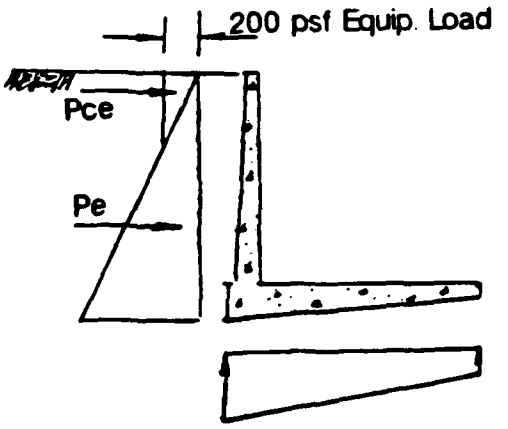
Highway Bridges

6-11 Highway bridges will be designed by local interests in accordance with applicable standards of American Association of State Highway and Transportation Officials.



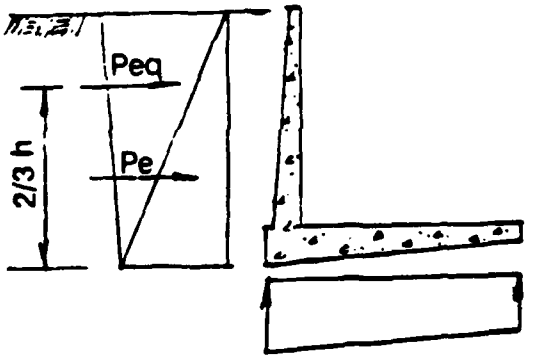
CASE I

Horizontal Earth Pressure



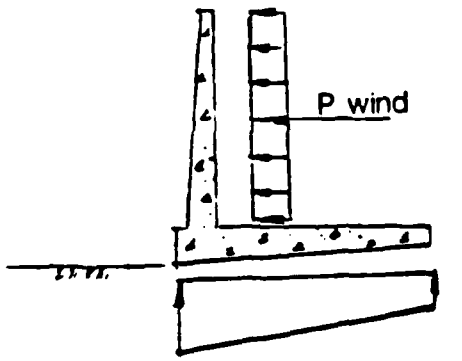
CASE II

Case I with Construction Equipment Load



CASE III

Case I with Seismic Force

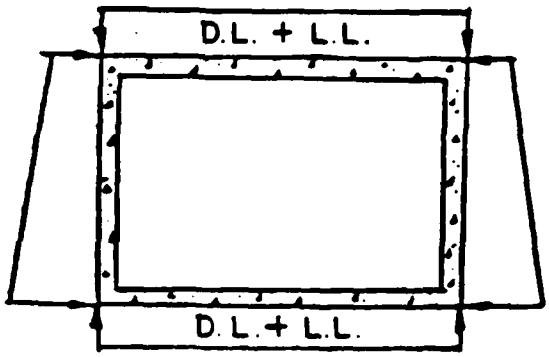


CASE IV

Wind Force with No Backfill under construction

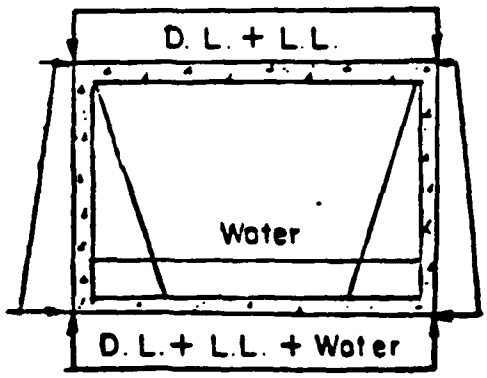
RETAINING WALL LOADING CONDITIONS

Note: Loads are unfactored



Lateral Soil Pressure
+ L.L. Surcharge

CASE I NORMAL LOAD
DESIGN OF CORNER



1/2 Lateral Soil
Pressure

CASE II NORMAL LOAD WITH WATER
DESIGN OF MIDSPAN

BOX CULVERT LOADING CONDITIONS

Note: Loads are unfactored.

VII. RELOCATION OF STREETS, RAILROAD, AND UTILITIES

General

7-01 Under the recommended plan for the Oak Street Drain Channel, replacement of seven bridges and one railroad crossing will be necessary. In addition, relocation of several major utilities will be required. The existing Riverside Freeway and its ramps will remain in operation during the construction of the channel as the box concrete section will be installed by tunnelling and jacking. The local sponsor will be responsible for all design and cost in connection with replacement of street crossings including detours and relocation of underground utilities. The Federal Government will be responsible for the replacement of the railroad bridge (fig. 9) including the shoofly and its appurtenances.

Streets

7-02 Existing concrete bridges at the crossing of Ontario Avenue (sta. 161+52), 10th Street (sta. 105+81), 8th Street (sta. 98+25), 6th Street (sta. 90+18), Pomona Road (sta. 60+03), and Railroad Street (sta. 47+92) will be replaced by a covered reinforced concrete rectangular section. Corona High School's wooden bridge (sta. 118+28), will also be replaced by a covered rectangular section. During construction of the bridge a detour will be made available at Ontario Avenue, 6th Street, and Pomona Road. During bridge construction 10th Street, 8th Street and Railroad Street will be temporarily closed. For construction of the covered section from station 79+00 to station 65+40, 'D' Street will be temporarily closed, two-way traffic will be limited to one side of Lincoln Avenue, and a detour will be provided for the on and off ramps of Riverside Freeway. Due to heavy traffic on the Riverside Freeway, the Transportation Department of the State of California has indicated that the only acceptable channel construction method is by tunnelling and jacking the rectangular concrete box channel into its final position.

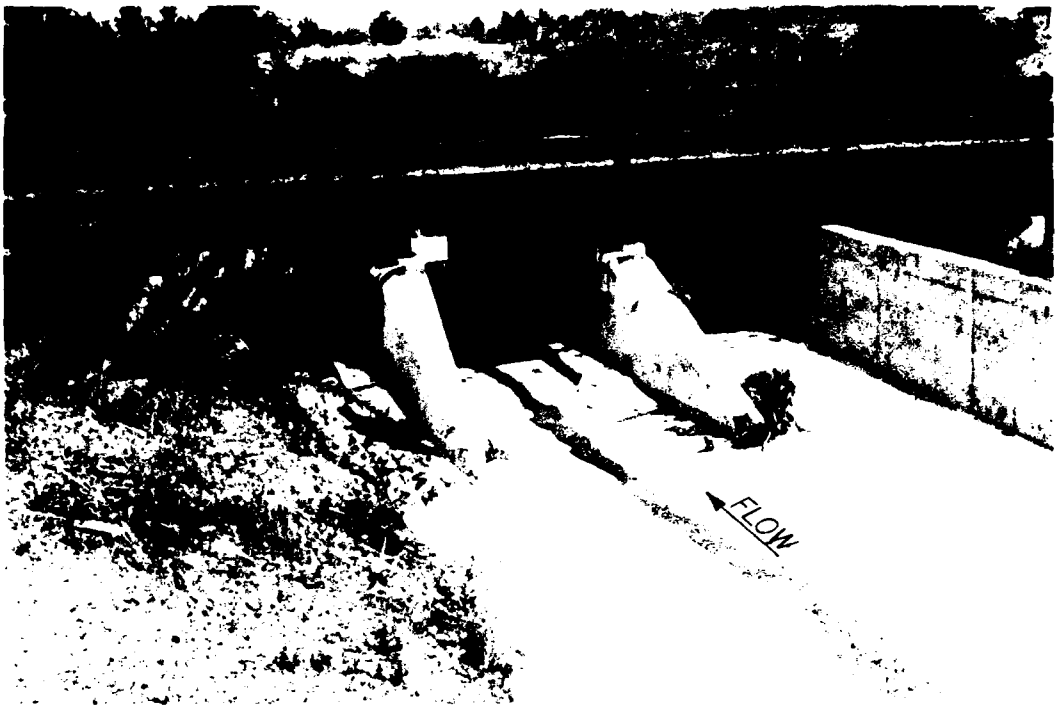


Figure 10. Existing Santa Fe Railroad bridge crossing Oak Street Drain.

Railroad

7-03 The existing Santa Fe Railroad bridge at channel Sta. 40+86 is a 65-foot long, and 32-foot wide double track timber bridge. The existing bridge would be replaced by a reinforced concrete box structure with a clear span of 26 feet. A shoofly of approximately 2100 feet in length would be provided on the north side and parallel to the existing track during the construction of the railroad bridge. It is proposed to complete the design and construction of the railroad bridge and the shoofly by agreement with the Atchinson, Topeka and Santa Fe Railway Company. A draft cost reimbursible agreement is provided in Appendix A.

Utilities

7-04 The alignment and grade of the proposed channel will be designed to avoid relocation or modification of existing utilities which are crossing or in the vicinity of Oak Street Drain. The existing 9-foot diameter waterline at Sta. 194+14 owned by Metropolitan Water District will remain in place. However, at Sta. 38+05 the existing 30-inch high pressure gasline owned by Southern California Gas Company will be relocated from elevation 576 to elevation 562, which would be 5 feet below the invert of the proposed channel. The owner, sizes and disposition of water, sewer and gas service lines, and overhead power and telephone lines are listed in table VII-1.

Table VII-1. List of Existing Utilities.

No.	Channel Sta.	Existing Utility	Owner	Remarks
1	194+15	108-inch waterline	Metro. Water Distr.	Waterline to remain.
2	161+92	Electrical Duct	Southern Cal. Edison	Duct to remain.
3	161+77	16-inch waterline	City of Corona	To be relocated.
4	161+60	24-inch waterline	City of Corona	To be relocated.
5	161+12	8-inch Irrig. line	Private	To be relocated.
6	107+00	24-inch waterline	City of Corona	To be relocated.
7	106+20	8-inch waterline	City of Corona	To be relocated.
8	106+06	4 MCD telephone	Pacific Telephone	To be relocated.
9	106+01	4-inch waterline	City of Corona	To be relocated.
10	105+73	8-inch sewerline	City of Corona	To be relocated.
11	105+61	8-inch waterline	City of Corona	To be relocated.
12	90+62	6-inch waterline	City of Corona	To be relocated.
13	90+60	15 MCD Telephone	Pacific Telephone	To be relocated.
14	90+57	6 MCD Telephone	Pacific Telephone	To be relocated.
15	89+91	8-inch sewerline	City of Corona	To be relocated.
16	74+60	6-inch waterline	City of Corona	To be protected in place.
17	74+31	10-inch sewerline	City of Corona	To be relocated.
18	72+96	14-inch waterline	City of Corona	To be protected in place.
19	72+90	6-inch waterline	City of Corona	To be protected in place.
20	72+63	12-inch sewerline	City of Corona	To be relocated.
21	72+15	6-inch waterline	City of Corona	To be protected in place.
22	59+84	8-inch waterline	City of Corona	To be relocated.
23	48+07	4-inch waterline	City of Corona	To be protected.
24	48+01	12-inch sewerline	City of Corona	To remain.
25	47+75	Aban. 16-in. wtrlne	City of Corona	To be removed.
26	37+63	16-inch Oil line	4 Coroner Pipe Line Co.	To be relocated.
27	38+05	30-inch Gas line	So. Cal. Gas Co.	To be relocated.
28	18+63	30-inch sewerline	Santa Ana watershed project authority	To remain.

VIII. ACCESS ROADS

General

8-01 The berm on one or both sides of the proposed open rectangular concrete channel will be utilized as vehicular access road for the inspection and maintenance of the flood control project. One of the berms will be paved with asphaltic concrete to permit all-weather usage of the berm. The access road will join a public street wherever possible, otherwise if necessary a turnaround will be provided. A 5-foot high chain link fence will be installed on top of the channel walls and a gate will be provided at the entrance for preventing the public from entering the access road. A 15-foot wide vehicular ramp to the invert of the channel will be provided at station 91+40.

Geometric Design

8-02 Vehicular access roads (including ramps) will be designed in accordance with the report entitled "A Policy on Geometric Design of Rural Highways" by the American Association of State Highway and Transportation Officials. The design will also conform to the standards of the Federal Highway Administration for secondary roads of low usage. Top of the access road will be designed to drain toward and over the top of the channel wall.

Pavement Section

8-03 The flexible pavement section forming the access roads was designed in accordance with Department of the Army TM 5-822-5, "Flexible Pavements for Roads, Streets, Walks, and Open Storage Areas." The Geotechnical Appendix addresses pavement design values and traffic criteria: Category II traffic, Class F road, and Design Index 1. The following pavement section was selected to satisfy pavement design values and traffic criteria for access roads:

Materials	Thickness (inches)
Asphaltic Concrete	2
Prime Coat	--
Stabilized Aggregate Base Course compacted to 100%	4
Levee Fill or Channel Wall Backfill compacted to 95%	6

IX. ENVIRONMENTAL EVALUATION

Environmental Impacts

9-01 An environmental impact statement for the proposed flood control improvements along the mainstem of Santa Ana River including Santiago Creek and Oak Street Drain was presented in the Phase I General Design Memorandum (GDM) dated September 1980. For this Phase II GDM, the environmental evaluation has been updated and broadened to include the extension of downstream portion of Oak Street Drain to Temescal Wash Channel.

9-02 Based on predicted land use for the project area and areas immediately adjacent to it, it is unlikely that the project will have significant long-term environmental impacts except for removal of riparian and other vegetation in the lower reaches of the project area. The area is rapidly developing and could be expected to be urbanized within the near future; the project may contribute to increasing the pace of this development but is unlikely to influence the nature and extent of the development itself. There are no cultural resources in the project area, and no threatened or endangered species have been documented in the project area.

9-03 Impacts during construction of the project will be short-term increases in noise, dust, and traffic, along with losses of esthetic values and a decrease in air quality during excavation and construction activities.

9-04 The primary long-term impacts from the project will be loss of some vegetation, particularly riparian vegetation in the lower channel reaches, and a loss of esthetic quality along the channel. No mitigation is necessary or required for the removal of some vegetation and loss of esthetic quality.

Construction Considerations

9-05 There are a number of alternatives for alleviation or compensation for the long-term impacts to vegetation and esthetics. In general, they involve revegetation of the channel areas in the lower reach and planting of shrubs and trees along the landside channel levees and rights-of-way.

X. DIVERSION AND CONTROL OF WATER DURING CONSTRUCTION

Available climatological information indicates that nearly all of the annual rainfall of approximately 13 inches in the Oak Street Drain drainage area occurs during the rainy season between mid-October and mid-April, and the remainder of the year is considered the dry period. Construction of the channel will be scheduled to take place during the period from April to October. The existing Oak Street Debris Basin will be utilized to prevent runoff from the canyons from entering the construction area, and the existing culvert under Riverside Freeway will remain operational until the completion of the proposed reinforced concrete box under the Freeway. Water from the local commercial area will be in small amounts and can be controlled by the construction of small dikes or bypass structures and the installation of pumps.

XI. REAL ESTATE REQUIREMENTS

General

11-01 Construction of the proposed Oak Street Drain Channel will require a total of 34 acres of permanent rights-of-way of which 13 acres are already owned by the Riverside County Flood Control and Water Conservation District, 7 acres are owned by the City of Corona, 3 acres are located within the existing public street or freeway rights-of-way, and the remaining 11 acres are privately owned. In addition, approximately 7 acres of temporary construction easements for detours, shoofly, haul roads, contractor's work area, and storage yard will be needed.

Acquisition

11-02 In accordance with the authorizing documents, the local sponsoring agency will be responsible for acquiring and bearing all costs in association with the acquisition of channel rights-of-way and construction easements. Acquisition of both rights-of-way and easements will be completed prior to the initiation of construction. The estimated cost of real estate is:

Land	$1,978,000
Improvements	333,000
Damages	200,000
Contingencies (20%)	502,000
Relocation (PL 91-646)	0
Administrative	295,000
Total Costs	$3,308,000

XII. COST ESTIMATES

First Costs

12-01 The first cost of the proposed Oak Street Drain Channel is presently estimated at $20,652,000. The unit price for various items of work was based on the recent construction bid prices of September 1985 of Los Coches Creek in San Diego County, California. In addition, the rapid urbanization along the project area was considered a major contributing factor to increased construction cost. In accordance with EM 1110-2-1301, a 15 percent contingency is added to the estimated construction cost. The 10 percent and 7 percent of construction cost were selected as the cost for engineering and design, and supervision and administration, respectively. These percentages are based on the actual prevailing rates experienced by the Los Angeles District Office. The costs for rights-of-way and construction easements were based on current market land value. Relocation of utilities were based on existing utility data furnished by the Riverside County Flood Control and Water Conservation District. First costs are shown in table XII-1.

Operation and Maintenance

12-02 Upon completion of the proposed flood control channel project, the annual operation and maintenance cost for flood control features is presently estimated at $55,000, which is based on the cost for similiar type of channel experienced by the Los Angeles District.

Comparison of Estimates

12-03 A comparison of estimated project costs between the one as presented in the Phase I General Design Memorandum dated September 1980, the escalated Phase I GDM estimate (October 1987 price level), and the present is shown in table XII-3. The escalated Phase I GDM estimate was based on the Phase I design features and their costs, except that the estimate includes a price level increase as indicated by the Engineering News-Record indexes between October 1979 and October 1987 which is the

present base. The reasons for the differences between the escalated Phase I GDM estimate and the present estimate are presented in the following paragraphs.

a. The increase of $114,000 in construction cost of the railroad relocation is mainly due to the result of refinement in the cost estimate.

b. The increase in construction cost of $818,000 for the open rectangular section is due to higher concrete cost than previously anticipated due to additional urbanization which restricts the space necessary for construction and affects the vehicular access to the project site.

c. An addition of $1,116,000 for the construction of the trapezoidal section is due to extension of the proposed channel to Temescal Wash to provide the adequate point of disposal for floodwaters.

d. The decrease of $177,000 in the construction cost of the covered section is due to the result of a structural design which indicated that the quantity of concrete, steel, and Portland Cement will be less than the Phase I General Design Memorandum estimate.

e. The decrease of $606,000 in construction cost for other features is due to (1) design change which reduced the length of Mangular Channel ($107,000), (2) elimination of the downstream end protection ($273,000), (3) limiting asphaltic pavement to only one berm ($67,000), and (4) reduction in fencing cost from the projected $11.25 to $5.00 per linear foot ($159,000).

f. Increase of $596,000 in engineering and design, and $83,000 in supervision and administration are the result of increases in the overall construction cost.

g. Inclusion of the cost for the preparation of Operation and Maintenance Manual increases the project first cost by $30,000.

h. A $1,924,000 increase in the cost for land is due to the fact that the market value of the land in the project area increased at a faster rate than the price-level index.

i. The estimated construction cost for highways and bridges increased by $996,000 can be attributed to the change of construction methods by the adoption of jackirg the concrete box into place underneath the Riverside Freeway and providing H-pile shoring for large portion of the channel between station 79+00 and station 67+70.

j. The decrease of $436,000 in the estimated cost for relocation of utilities is due to the change of channel alignment and profile to avoid the relocation of existing utilities such as the 108-inch waterline owned by Metropolitan Water District and waterlines at Lincoln Avenue south of Riverside Freeway.

Table XII-1. Detailed Estimate of First Cost.
(October 1987 Price Level)

Acct. No.	Description	Quantity	Unit	Unit Price	Amount
	First Cost For Flood Control				
	Construction and Railroad				
02.	Relocation Costs:				
	Railroad Bridge Relocation				
	Remove Exist. Bridge	1	JOB	L.S.	$12,000
	Excavation	3,500	CY	$4.00	14,000
	Fill, Compacted	1,000	CY	6.00	6,000
	72" CMP	210	LF	310.00	65,000
	Sand Bags	1	JOB	L.S.	3,000
	Crib Wall	1,200	LF	5.10	6,000
	Shoofly and New Track	(See page A-27)			207,000
	Concrete, Invert	70	CY	80.00	6,000
	Concrete, Walls	40	CY	143.00	6,000
	Concrete, Roof	60	CY	155.00	9,000
	Cement, Portland	960	CWT	5.00	5,000
	Steel, Reinf.	21,000	LB	0.42	9,000
	Encase 16" Oil Line	1	JOB	L.S.	5,000
	Remove Shoofly	1	JOB	L.S.	20,000
	Utilities				
	Water Lines	1	JOB	L.S.	47,000
	Sewer Lines	1	JOB	L.S.	11,000
	Gas Lines	1	JOB	L.S.	19,000
	Oil Line	1	JOB	L.S.	11,000
09.	Channel Costs				
	Diversion and Control of Water	1	JOB	L.S.	74,000
	Clear and Remove Obstructions	1	JOB	L.S.	500,000
	Open Rectangular Section:				
	Excavation	172,000	CY	2.84	488,000
	Compacted Fill	83,000	CY	7.25	602,000
	Concrete, Wall	10,300	CY	147.00	1,514,000
	Concrete Invert	15,600	CY	127.00	1,981,000
	Cement, Portland	146,000	CWT	5.00	730,000
	Steel, Reinforcing	1,865,000	LB	0.42	783,000
	Subdrainage System	1	Job	L.S.	15,000
	Disposal of Excavated Material	77,000	CY	2.00	154,000
	Covered Channel from Sta. 76+65 to 74+75 and Sta. 74+15 to Sta. 73+60				
	Excavation	8,000	CY	2.84	23,000
	Shoring	245	L.F.	800.00	196,000
	Compacted, Fill	5,000	CY	7.25	37,000
	Concrete, Roof	290	CY	180.00	52,000

Table XII-1. (Continued)

Acct. No.	Description	Quantity	Unit	Unit Price	Amount
	Concrete, Walls	270	CY	147.00	40,000
	Concrete, Invert	340	CY	127.00	43,000
	Cement, Portland	5,100	CWT	5.00	25,000
	Steel Reinforcing	104,000	LB	0.42	43,000
	Low Flow Channel Sta. 205+00 to Sta. 202+85	1	JOB	L.S.	22,000
	Pier Nose Extension Sta. 80+37 to Sta. 80+10	1	JOB	L.S.	4,000
	Transition Section Sta. 35+00 to Sta. 34+00	1	JOB	L.S.	57,000
	Open Trapezoidal Section·				
	Excavation	24,000	CY	2.84	68,000
	Compacted Fill	41,000	CY	7.25	297,000
	Stone, Grouted	7,100	CY	32.00	227,000
	Grouting Stonework	2,840	CY	58.00	165,000
	Concrete Wall and Invert	530	CY	141.00	75,000
	Cement, Portland	24,400	CWT	5.00	122,000
	Steel, Reinforcing	38,000	LB	0.42	16,000
	Equivalent Chan. from Sta. 79+00 to Sta. 76+65, Sta. 74+75 to Sta. 74+15 and Sta. 73+60 to Sta. 65+70 (See Table XII-2)	1	JOB	L.S.	603,000
	Lincoln Avenue Channel	1	JOB	L.S.	58,000
	Mangular Channel	1	JOB	L.S.	47,000
	Side Drain Structures	1	JOB	L.S.	118,000
	Asphaltic Concrete	2,800	TON	47.00	132,000
	Fence, Chain Link	31,700	LF	5.00	$ 158,000
	Esthetic Treatment	1	JOB	L.S.	315,000
	Subtotal				10,245,000
	Contingencies (15%)				1,536,000
	Subtotal, Construction				11,781,000
30.	Engineering and Design				558,000
	Pre-Construction E & D				1,000,000
31.	Supervision and Administration (6%)				707,000
51.22	Operation and Maintenance Manual				30,000
	Total Flood Control Construction Cost				14,076,000
	LANDS AND DAMAGES (See Page XI-1)	1	JOB	L.S.	3,308,000
	Relocations:				
	Highway Bridges and Detours				
	Ontario Avenue	1	JOB	L.S.	65,000
	Corona High School	1	JOB	L.S.	12,000

Table XII-1. (Continued)

Acct. Do.	Description	Quantity	Unit	Unit Price	Amount
	10th Street	1	JOB	L.S.	114,000
	8th Street	1	JOB	L.S.	50,000
	6th Street	1	JOB	L.S.	118,000
	Covered Section From Sta. 79+00 to Sta. 65+70 (See Table XII-2)	1	JOB	L.S.	1,944,000
	Pomona Road	1	JOB	L.S.	70,000
	Railroad Street	1	JOB	L.S.	45,000
	Utilities				
	Power Lines	1	JOB	L.S.	11,000
	Telephone Lines	1	JOB	L.S.	21,000
	Sum				2,450,000
	Contingencies (15%)				367,000
	Engineering and Design (10%)				282,000
	Supervision and Administration (6%)				169,000
	Subtotal, Relocation Cost				$3,268,000
	Total Cost for Lands & Damages				$6,576,000
	TOTAL PROJECT COST				$20,652,000

Table XII-2. Detailed Cost Estimate for Covered Section Between Station 79+00 and Station 65+70. (October 1987 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Covered Section From Sta. 79+00 to Sta. 76+65, Sta. 74+75 to Sta. 74+15, and Sta. 73+60 to Sta. 67+70				
Excavation	29,000	CY	$2.84	$82,000
Shoring	550	LF	800.00	440,000
Compacted Fill	18,000	CY	7.25	130,000
Concrete, Roof	1,040	CY	180.00	187,000
Concrete, Walls	980	CY	147.00	144,000
Concrete, Invert	1,220	CY	127.00	155,000
Cement, Portalnd	18,300	CWT	5.00	92,000
Steel, Reinforcing	373,000	LB	0.42	157,000
Lincoln Avenue Detour	1	JOB	L.S.	44,000
Detour for Ramps	1	JOB	L.S.	106,000
Covered Section From Sta. 67+70 to Sta. 65+70				
Concrete, Roof	370	CY	168.00	62,000
Concrete, Walls	260	CY	168.00	44,000
Concrete, Invert	430	CY	168.00	72,000
Cement, Portland	6,000	CWT	5.00	30,000
Steel, Reinforcing	127,000	LB	0.50	64,000
Prepare Site for Jacking	1	JOB	L.S.	38,000
Excavation	3,100	CY	70.00	217,000
Jacking Box	1	JOB	L.S.	483,000
Subtotal				$2,547,000
Equivalent Open Rectangular Channel from Sta. 79+00 to Sta. 76+65, Sta. 74+75 to Sta. 74+15, Sta. 73+60 to Sta. 65+70				
Excavation	44,000	CY	2.84	125,000
Compacted Fill	5,500	CY	7.25	40,000
Concrete, Wall	830	CY	147,000	122,000
Concrete, Invert	1,310	CY	127.00	166,000
Cement, Portland	14,100	CWT	5.00	71,000
Steel, Reinforcing	161,000	LB	0.42	68,000
Fence, Chain Link	2,200	LF	5.00	11,000
Subtotal				$603,000
Difference (Bridge Cost)				$1,944,000

Table XII-3. Comparison of Estimated First Costs for Flood Control.

Cost Acct. No.	Description	Phase I GDM Oct. 1979	Phase I GDM Oct. '87	Present Estimate Oct. '87
	FIRST COST FOR FLOOD CONTROL CONSTRUCTION			
02	Railroad Bridge Modification	$ 212,000	$ 315,000	$ 429,000
	Utilities	-------	--------	101,000
09	Channel	6,789,000	10,100,000	11,251,000
	Open Rectangular Section	(4,359,000)	(6,485,000)	(7,303,000)
	Open Trapezoidal Section	(-------)	(--------)	(1,116,000)
	Covered Section	(939,000)	(1,397,000)	(1,220,000)
	Other Features	(1,491,000)	(2,218,000)	(1,612,000)
30	Engineering and Design	710,000	962,000	558,000
	Pre-Construction E & D	(-------)	(-------)	1,000,000
31	Supervision and Administration	491,000	624,000	707,000
51,22	Operation and Maintenance Manual	(-------)	(-------)	30,000
	TOTAL FIRST COSTS FOR FLOOD CONTROL	$8,202,000	12,001,000	14,076,000
	LANDS AND DAMAGES	$ 930,000	1,384,000	$3,308,000
	Relocations:			
	Highway and Road Bridges	1,527,000	2,272,000	3,268,000
	Covered Section Between Sta. 79+00 and Sta. 65+70	(829,000)	(1,233,000)	(2,593,000)
	All Other Bridges	(698,000)	(1,039,000)	(632,000)
	Utilities	390,000	580,000	(43,000)
	TOTAL LANDS & DAMAGES	2,847,000	4,236,000	$6,576,000
	TOTAL PROJECT COST	$11,049,000	16,237,000	$20,652,000

XIII. OPERATION AND MAINTENANCE

13-01 In accordance with authorizing law, the local sponsoring agency would be responsible for operation and maintenance of the channel upon completion of construction by the U.S. Army Corps of Engineers. An operation and maintenance (O&M) manual would be prepared after construction of the flood control improvements in accordance with ER 1130-2-304 "Project Operations" and applicable provisions of ER 1150-2-301 "Local Cooperation". The estimated cost for the preparation of the O&M manual is $30,000. The local sponsor would be responsible for the operation and maintenance of the flood control channel improvements. In general, the major items of operation and maintenance and their estimated annual costs would be as follows:

Item	Annual Cost
Operation	
Administration	$ 5,000
Inspection and evaluation	3,000
Maintenance	
Routine (fence repair, rip-rap, weeds, equipment, sealing, debris cleanup, etc.)	15,000
Miscellaneous	5,000
Major Replacement	
Access road (30 years)	3,000
Concrete invert	17,000
Subtotal	48,000
Continency 15%	7,000
TOTAL	$55,000

13-02 The existing debris basin is operated and maintained by the Riverside County Flood Control and Water Conservation District. In order to assure the Oak Street Drain Channel functions as designed, the local sponsor will be required to maintain a debris storage capacity of at least 168 acre-feet (75 percent of the design volume of 224 acre-feet). The local sponsor will be required to remove any debris exceeding the 75 percent limit.

XIV. DESIGN AND CONSTRUCTION SCHEDULE

Preparation of Plans and Specifications

14-01 Preparation of contract plans and specifications for the construction of the proposed flood control project will be initiated after the Phase II General Design Memorandum for the Santa Ana River is approved. The Oak Street Drain Channel is being considered as an initial construction unit; consequently, a set of contract plans and specifications is scheduled for completion by the end of March 1990.

Construction Schedule

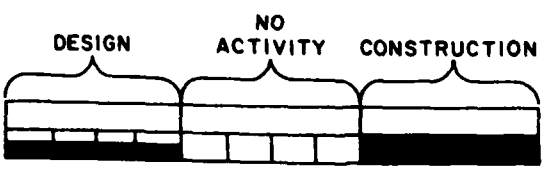
14-02 Construction of the channel is scheduled to start in spring of the year. Construction of the channel including the reinforced concrete box under Riverside Freeway will take approximately 12 months. Table XIV-1 shows a generalized construction schedule. This construction schedule may be modified as required, based on the total project requirements. The overall project construction schedule is provided in the main report.

Federal and non-Federal Funds Required by Fiscal Years

14-03 Federal and non-Federal funding requirements by fiscal year for the preparation of contract plans and specifications and construction are shown in the main report.

LINE NO	UNIFORM COST CLASSIFICATION	FEATURE ITEMS	PROJECT COST * ESTIMATE	TOTAL AS OF
1				
2	02	Relocation	530	
3	.4	Railroad Bridge	(429)	
4	.7	Utilities, Underground	(101)	
5				
6				
7	09	Channel	11,251	
8		Open Rectangular	(7,303)	
9		Open Trapezoidal Section	(1,116)	
10		Covered Section	1,220	
11		Other Features	(1,612)	
12				
13				
14	30	Engineering and Design	558	
15		Preconstruction E and D	1,000	
16				
17	31	Supervision and Administration	707	
18				
19	51.22	Operation and Maintenance Manual	30	
20				
21		Total First Cost For Flood Control	14,076	
22				
23		Lands and Damages	6,576	
24		Real Estate	(3,308)	
25		Relocations, Overhead Utilities	(3,268)	
26				
27		TOTAL	20,652	

* FUNDS IN THOUSANDS OF DOLLARS



SPL FORM 1 NOV 72 571

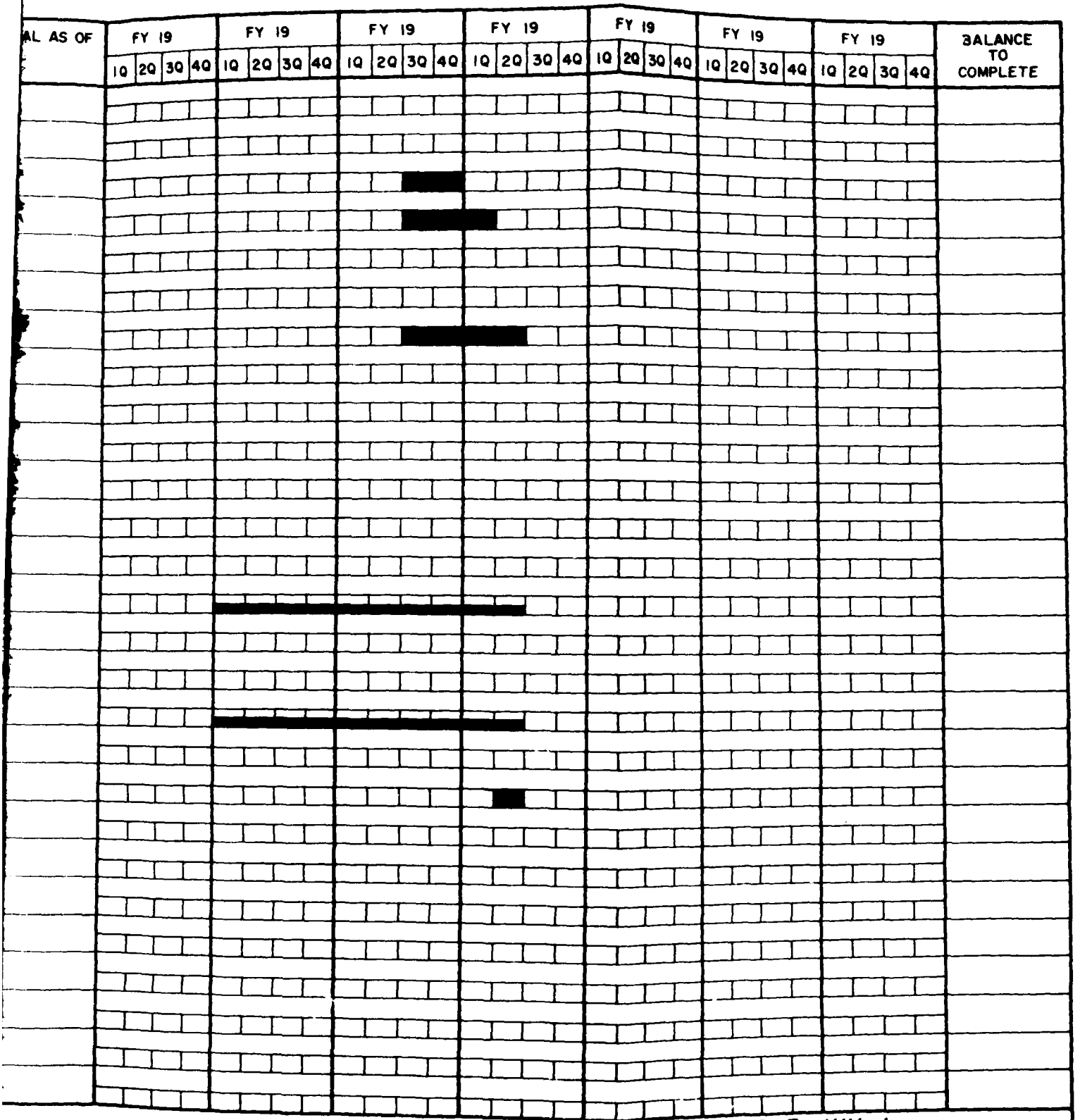
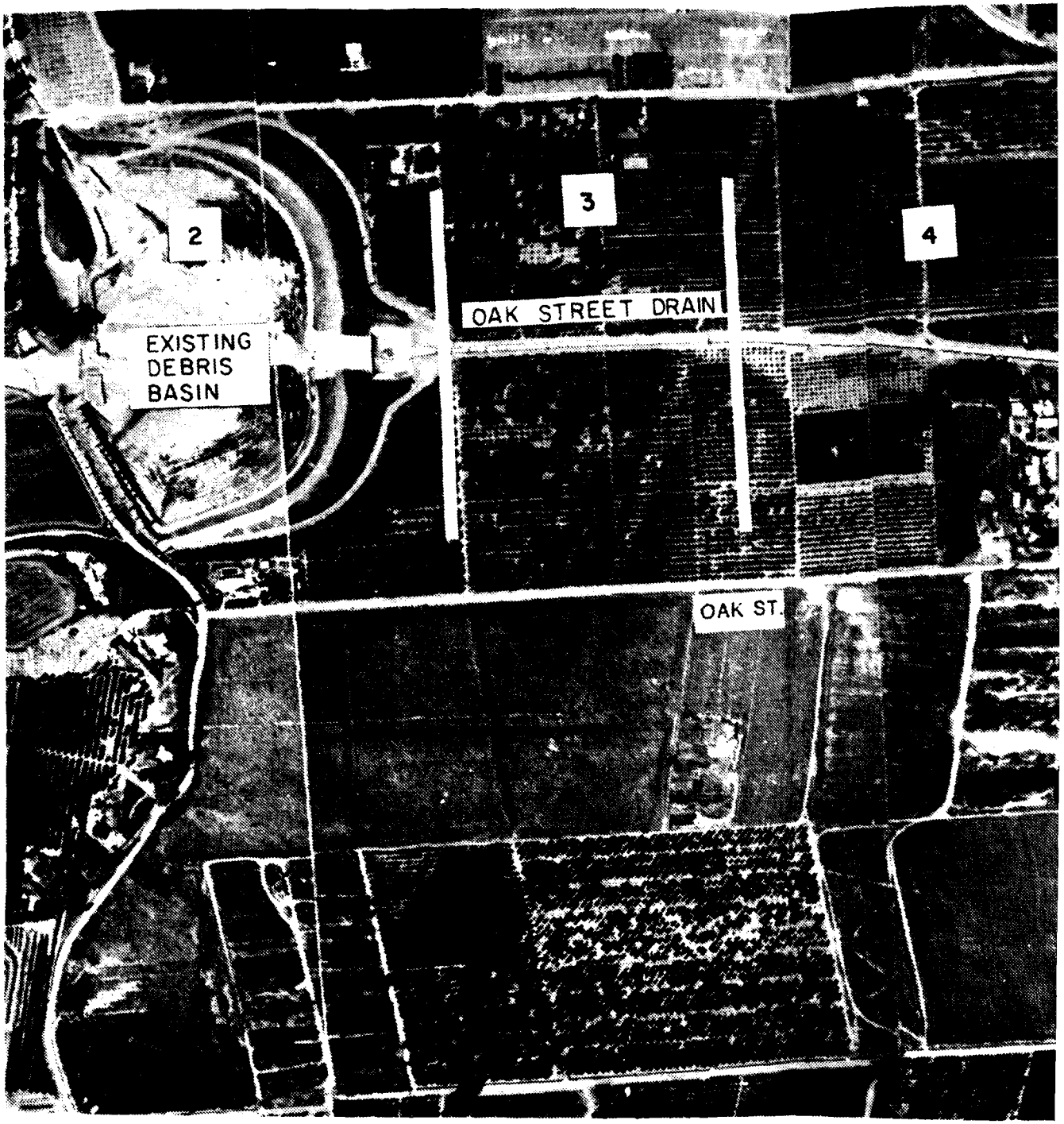


TABLE XIV-1
SANTA ANA RIVER MAINSTEM, CALIFORNIA
OAK STREET DRAIN
DESIGN AND CONSTRUCTION SCHEDULE
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY DESIGN MEMORANDUM NO.
DATED SEPTEMBER 1988 SHEET 1 OF 1

U.S. ARMY ENGINEER DISTRICT



3 INDICATES THE NUMBER OF PLATE ON WHICH THE PLAN AND PROFILE OF THE CHANNEL ARE SHOWN.

PLAN
1" = 500'

PLAN
1" = 500'

SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
INDEX MAP NO. 1

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 1

U.S. ARMY ENGINEER DISTRICT

8 INDICATES THE NUMBER OF PLATE ON WHICH THE PLAN AND PROFILE OF THE CHANNEL ARE SHOWN.

PLAN
1" = 500'

PLAN
1" = 500'

SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
INDEX MAP NO. 2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 12

U S ARMY ENGINEER DISTRICT

13 INDICATES THE NUMBER OF PLATE ON WHICH THE PLAN AND PROFILE OF THE CHANNEL ARE SHOWN.

PLAN
1" = 500'

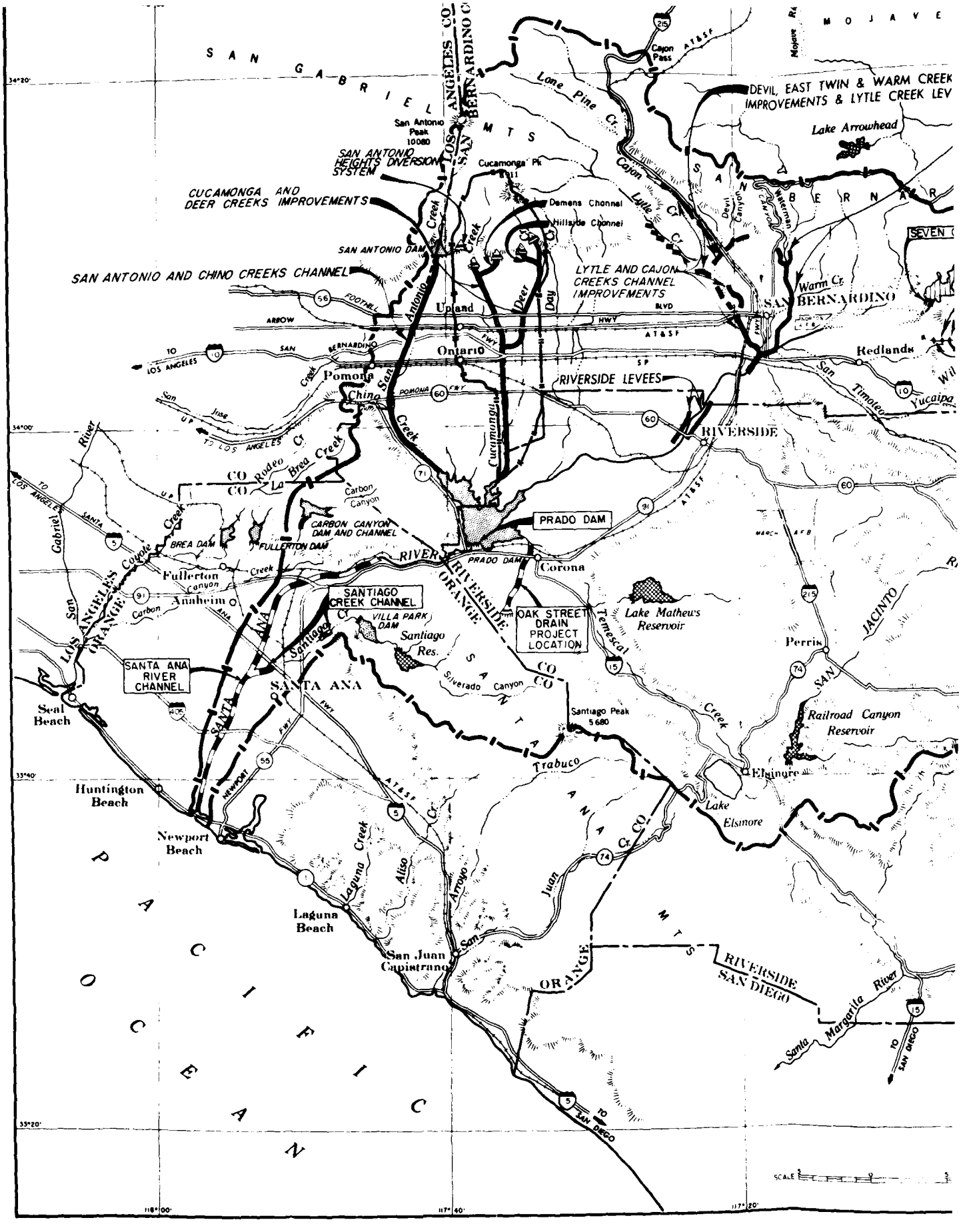
PLAN
1" = 500'

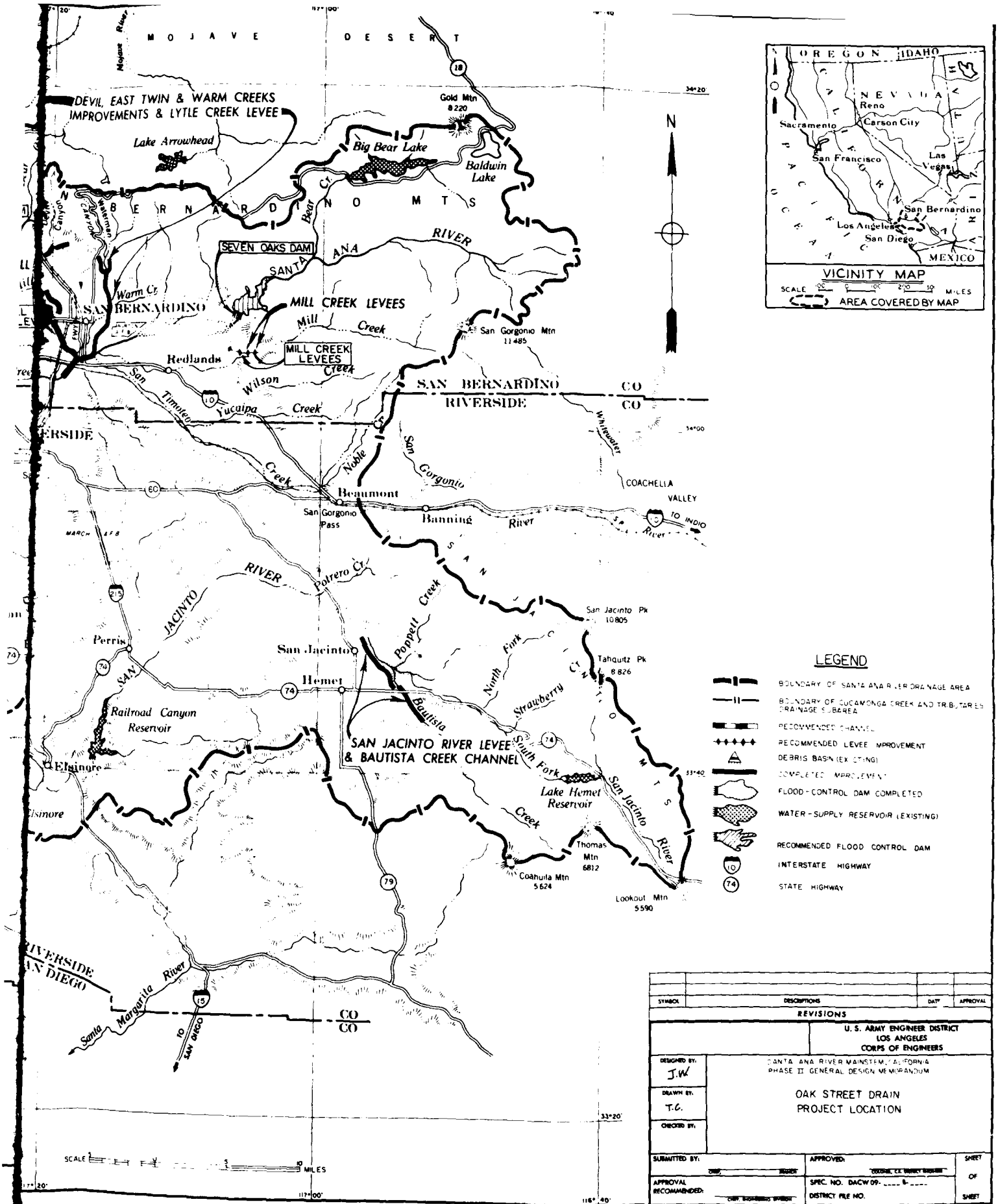
SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
INDEX MAP NO. 3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

FIGURE 13


SAN GABRIEL MTS
MOJAVE
Cajon Pass
Lone Pine Cr.
DEVIL, EAST TWIN & WARM CREEK IMPROVEMENTS & LYTLE CREEK LEV
Lake Arrowhead
San Antonio Peak 10080
SAN ANTONIO HEIGHTS DIVERSION SYSTEM
Cucamonga Pk
CUCAMONGA AND DEER CREEKS IMPROVEMENTS
Demens Channel
Hillside Channel
Cajon Cr.
Lytle Cr.
SAN BERNARDINO
SAN ANTONIO DAM
SAN ANTONIO AND CHINO CREEKS CHANNEL
LYTLE AND CAJON CREEKS CHANNEL IMPROVEMENTS
Warm Cr.
Upland
Ontario
Redlands
Pomona
Chino
RIVERSIDE LEVEES
Yucaipa
RIVERSIDE
Rodeo
La Brea Creek
Carbon Canyon
PRADO DAM
CARBON CANYON DAM AND CHANNEL
BREA DAM
FULLERTON DAM
Fullerton
Anaheim
Corona
SANTIAGO CREEK CHANNEL
VILLA PARK DAM
Santiago Res.
OAK STREET DRAIN PROJECT LOCATION
Lake Mathews Reservoir
Perris
SAN JACINTO
SANTA ANA RIVER CHANNEL
SANTA ANA
Seal Beach
Santiago Peak 5680
Railroad Canyon Reservoir
Trabuco
Elsinore
Huntington Beach
Newport Beach
Lake Elsinore
Laguna Beach
San Juan Capistrano
ORANGE
RIVERSIDE
SAN DIEGO
Santa Margarita River
PACIFIC OCEAN
34°20'
34°00'
33°40'
33°20'
118°00'
117°40'
117°20'



SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

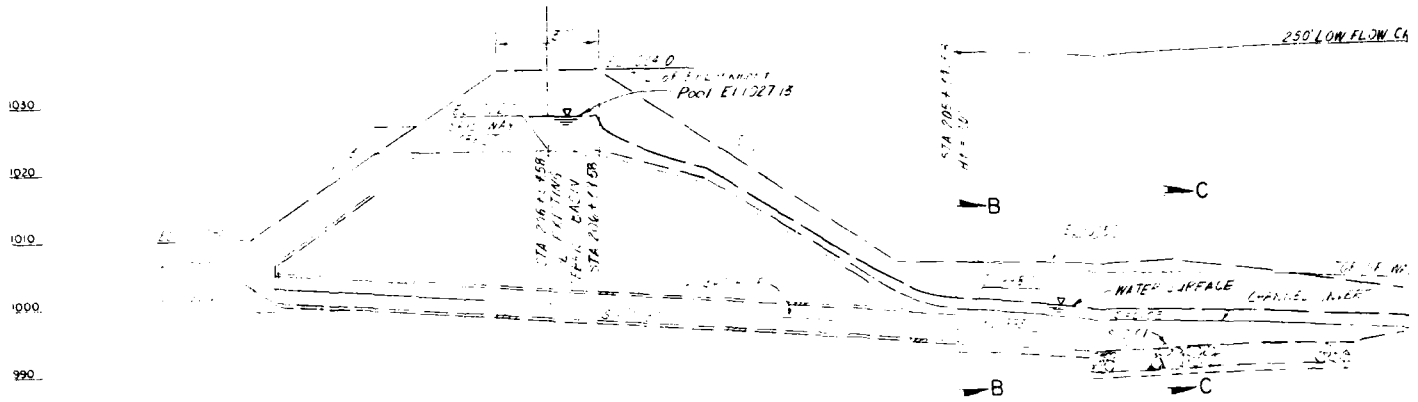
DESIGNED BY: J.W
DRAWN BY: T.C.
CHECKED BY:

SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

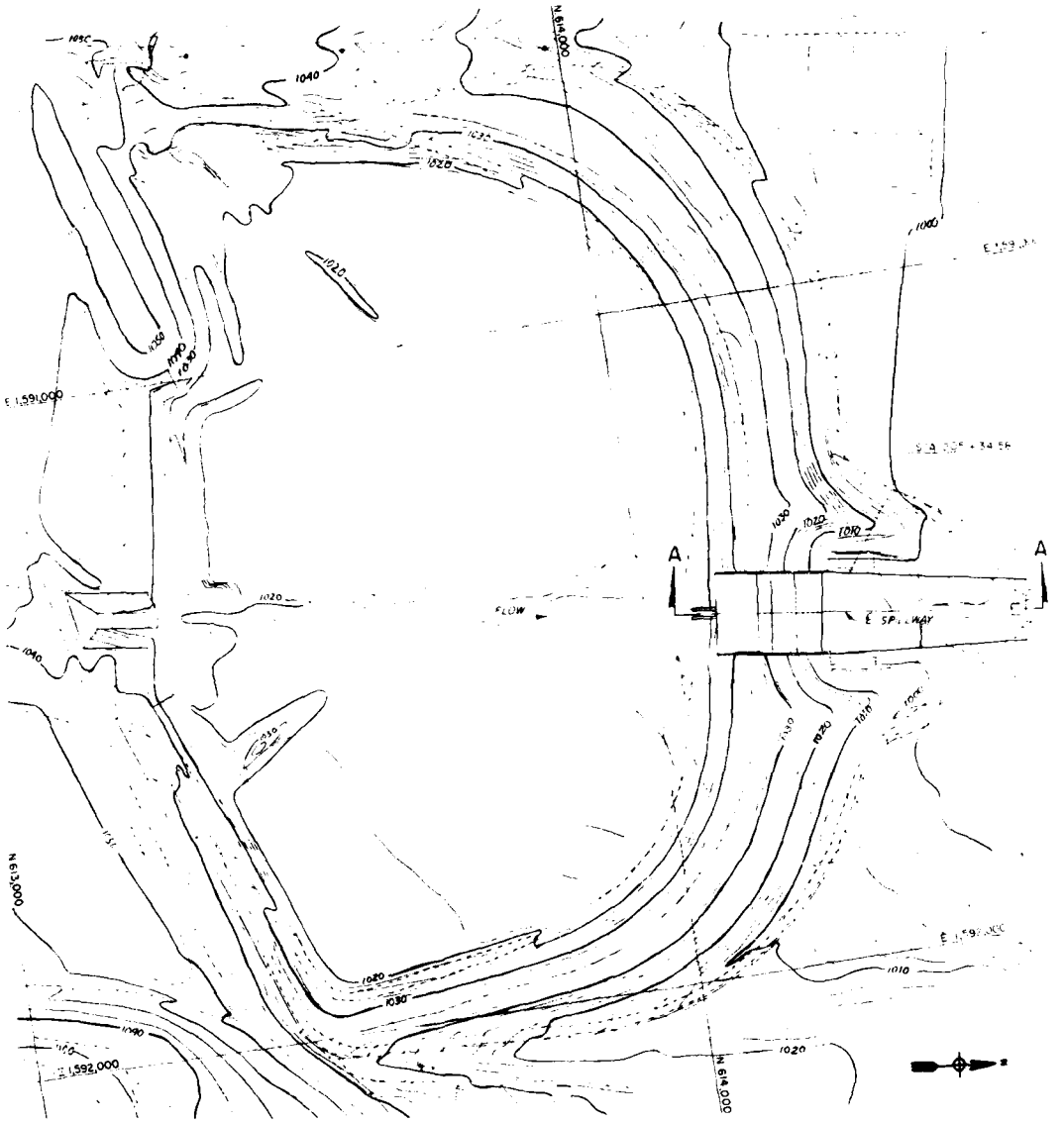
OAK STREET DRAIN
PROJECT LOCATION

SUBMITTED BY: CHIEF, ENGINEER
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
SPEC. NO. DACW09- ____ B- ____
DISTRICT FILE NO.
SHEET OF SHEET

PLATE I



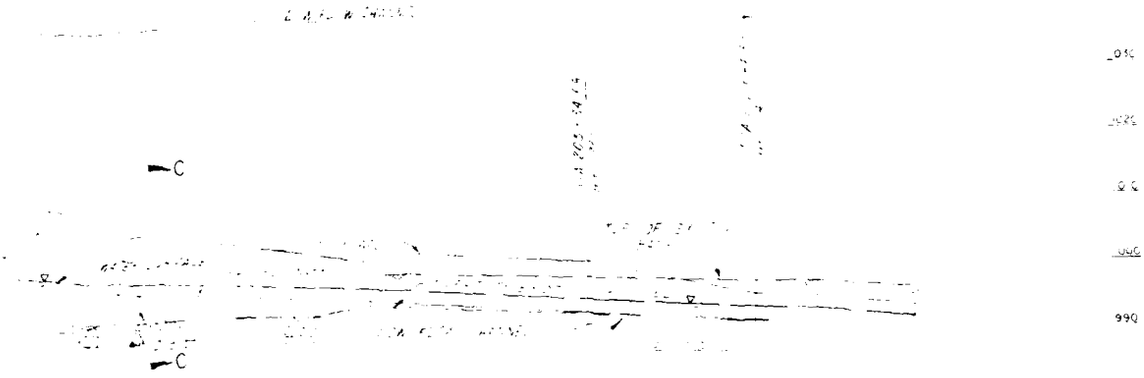
SECTION A-A



PLAN
(EXISTING OAK STREET DRAIN DEBRIS BASIN)
SCALE 100 0 100 200 300 FEET

SAFETY PAYS

VALUE ENGINEERING PAYS



SECTION A-A

SECTION B-B

A

SECTION C-C

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY

DRAWN BY

CHECKED BY

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

PLAN OF EXISTING

DEBRIS BASIN AND SECTIONS

SUBMITTED BY

DATE APPROVED

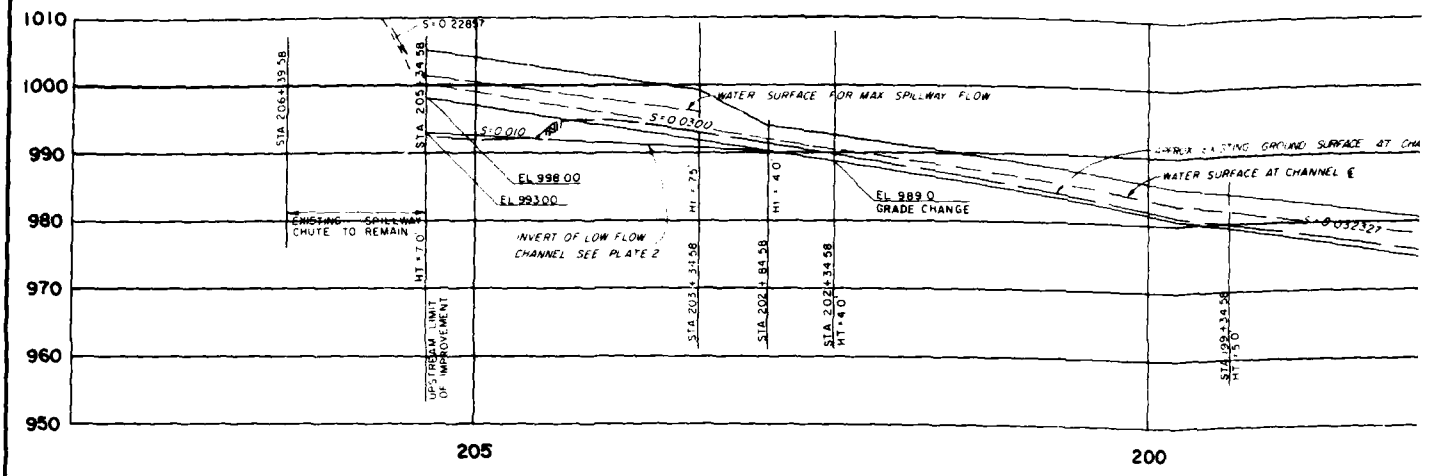
SPEC NO. DACW09-...-B-...

DISTRICT FILE NO.

SHEET

PLAT

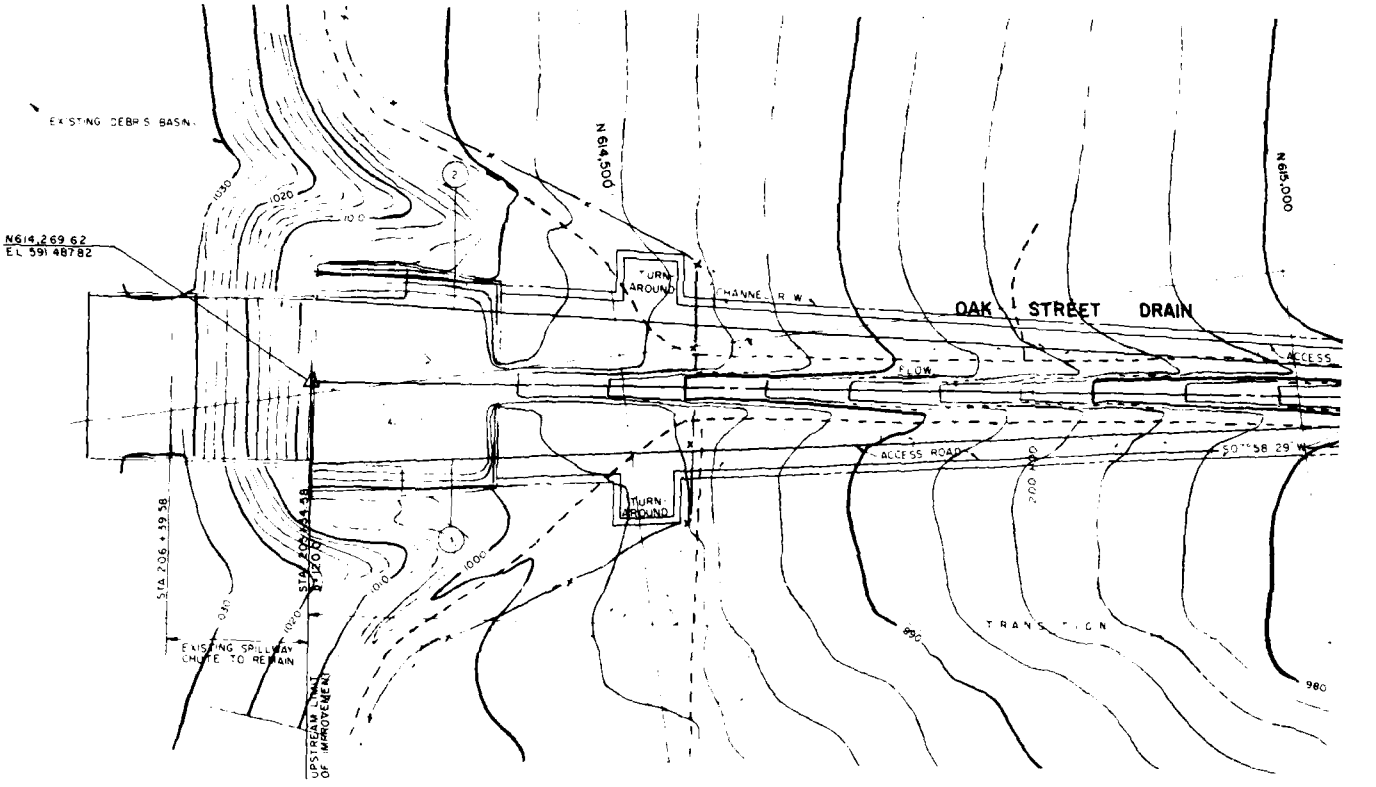
SAFETY PAYS



PROFILE

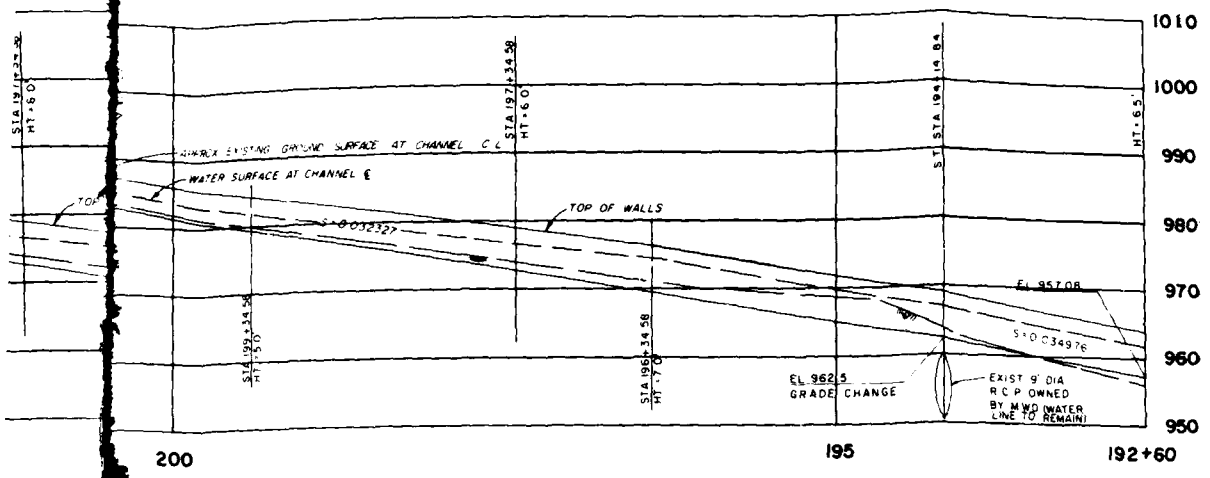
HORIZ SCALE 0 50 100 FEET

VERT SCALE 0 10 20 30 FEET

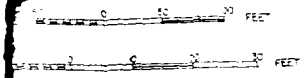


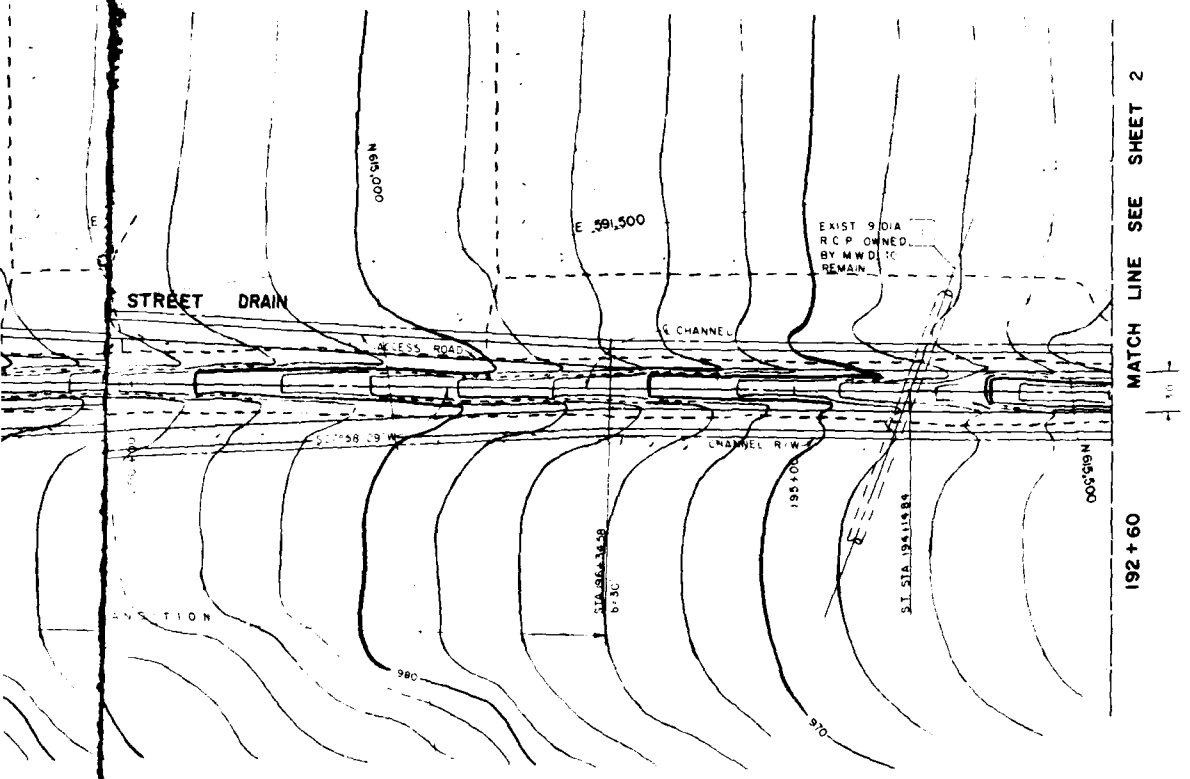
PLAN

HYDRAULIC ELEMENTS										
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
206+39.58	205+34.58	120' Rect.	.22857	4,300	3.42	3.5	10.5	1.3	37.5
205+34.58	202+34.58	Trans.	.03000	4,300	Varies	1.3	37.5	2.0	27.7
202+34.58	196+34.58	Trans.	.032327	4,300	Varies	2.0	27.7	3.0	30.2
196+34.58	194+14.84	30' Rect.	.032327	4,300	6.6	5.0	30.2	4.6	33.9
194+14.84	192+60	30' Rect.	.034976	4,300	6.6	4.6	33.9	4.4	35.9

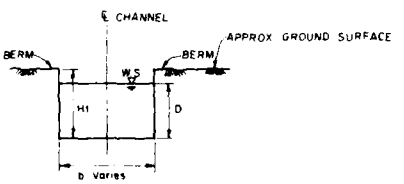


PROFILE





PLAN



TYPICAL SECTION
NOT TO SCALE

LEGEND

(NO) EXIST UTILITY, SEE TABLE VII-1 FOR DATA

(NO) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2 OR IV-2a FOR DATA

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

KAILAND ENGINEERING
CIVIL ENGINEERING SURVEYING LAND PLANNING
1000 JEFFERSON STREET, SAN DIEGO, CALIFORNIA, 92101

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

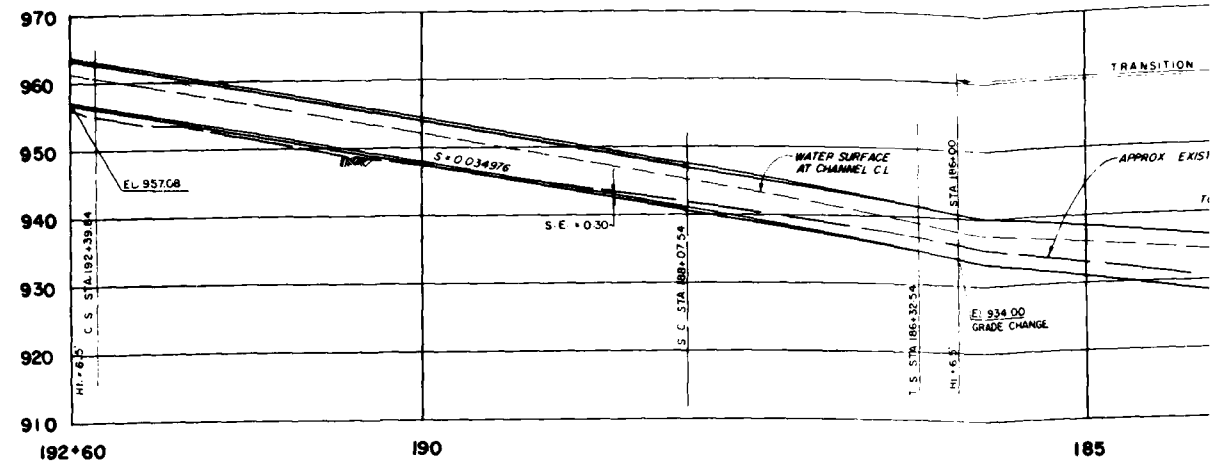
OAK STREET DRAIN

PLAN AND PROFILE

STA 205+34.58 TO STA 192+60

SUBMITTED BY:
DATE APPROVED:
SPEC. NO. DACW09-____-____
DISTRICT FILE NO.
SHEET 1 OF 14 SHEETS

PLATE 3



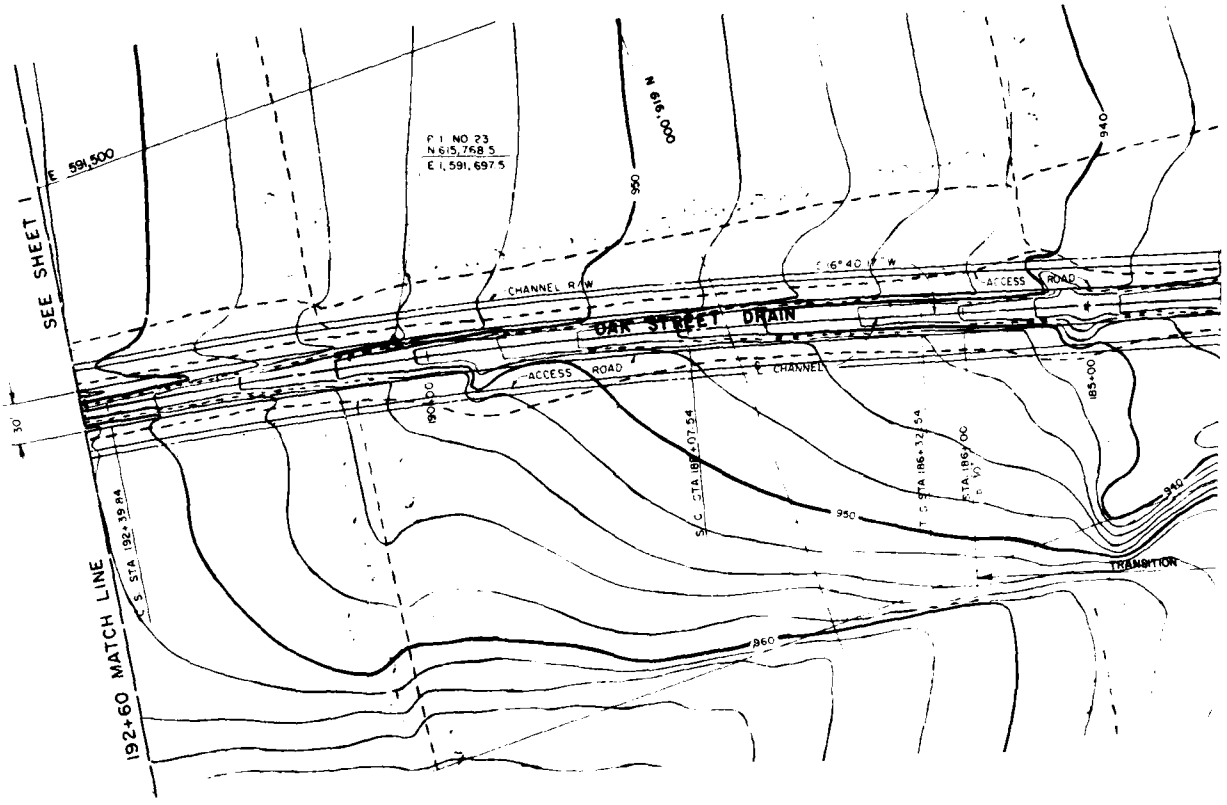
℄ CURVE DATA
I = 08° 41' 48"

CIRCULAR CURVE	SPIRAL CURVE NO. 23
Δ = 06° 11' 32"	Δs = 01° 15' 08"
R = 4000'	Ts = 391.76'
T = 216.36'	Ls = 175.00'
L = 432.30'	

PROFILE

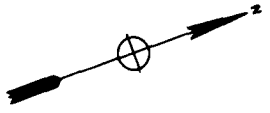
HORIZ SCALE 50 0 50 100 FEET

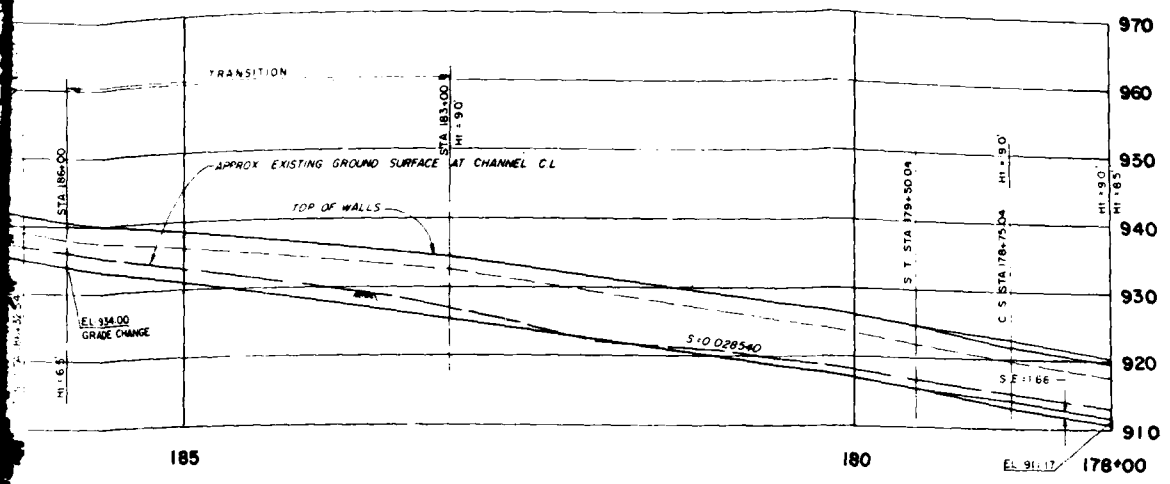
VERT SCALE 0 10 20 30



PLAN

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
192+60	186+00	30' Rect.	.034976	4,300	8.6	4.4	35.9	4.1	39.3
186+00	183+00	Trans.	.028540	4,300	VARIES	4.1	39.3	6.8	37.6
183+00	178+00	18' Rect.	.028540	4,300	12.1	6.8	37.6	6.5	39.8

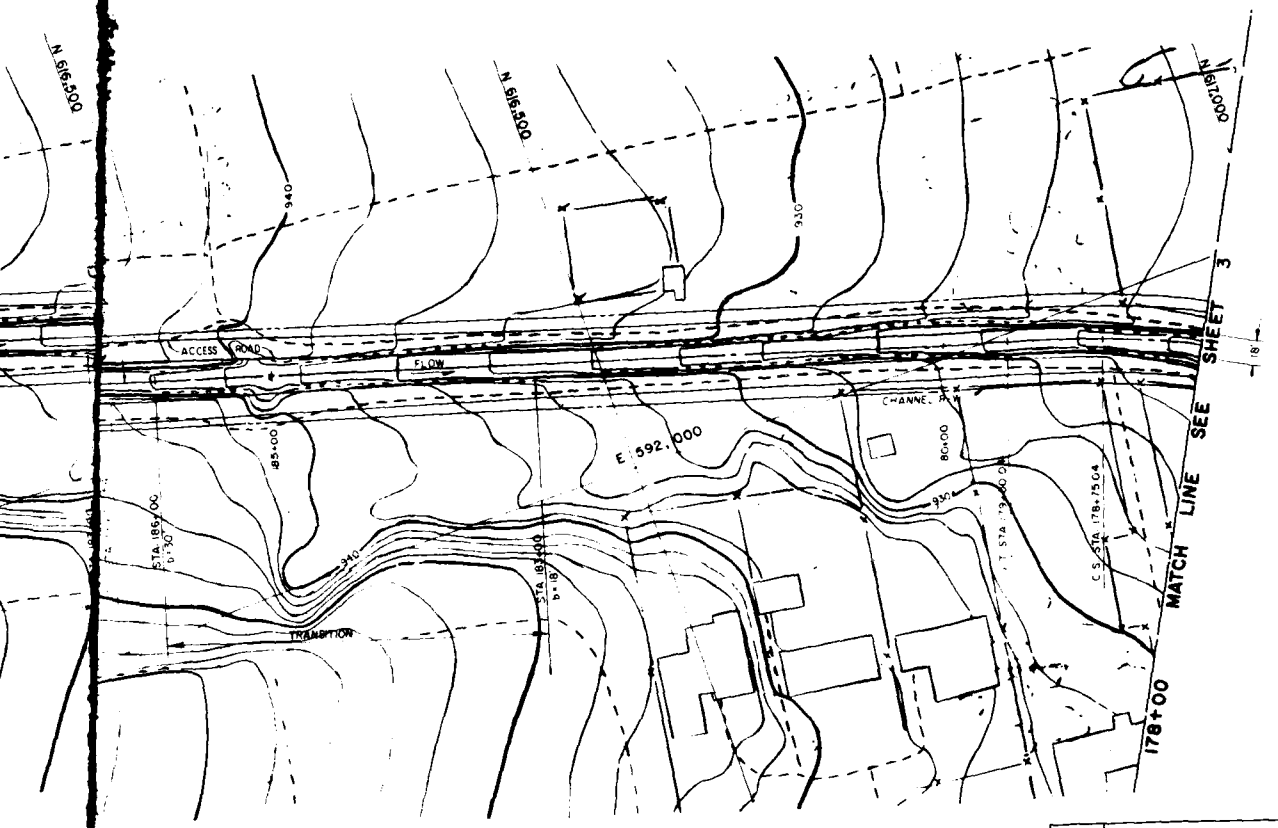




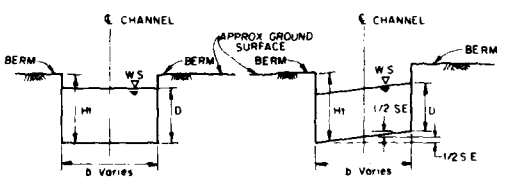
PROFILE

SCALE 50 0 50 100 FEET

10 0 5 10 20 30 FEET



PLAN



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

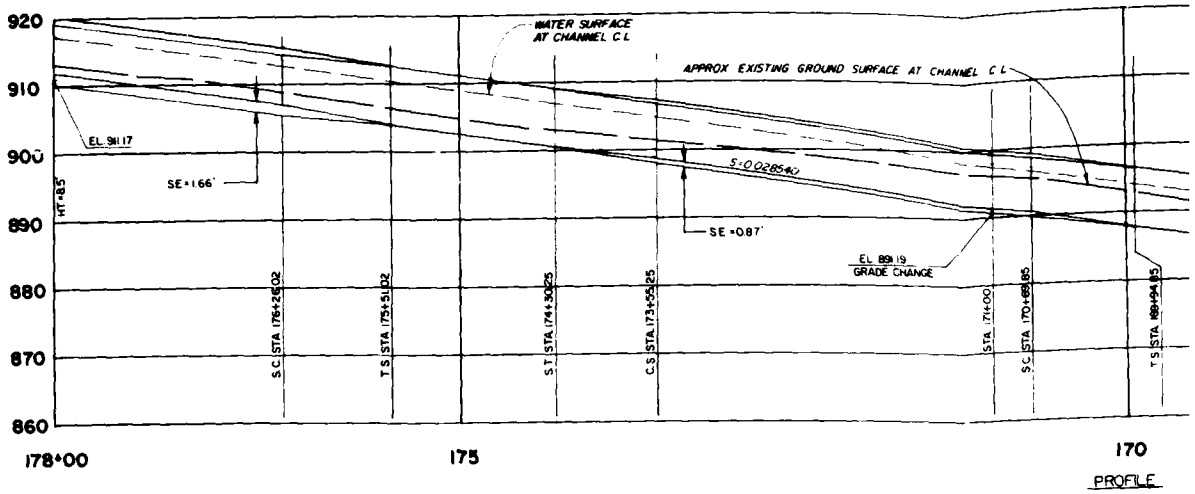
SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA 192+60 TO STA 178+00

SUBMITTED BY:
DATE APPROVED:
SPEC. NO. DACW09-___-8-____
DISTRICT FILE NO.
SHEET 2 OF 14

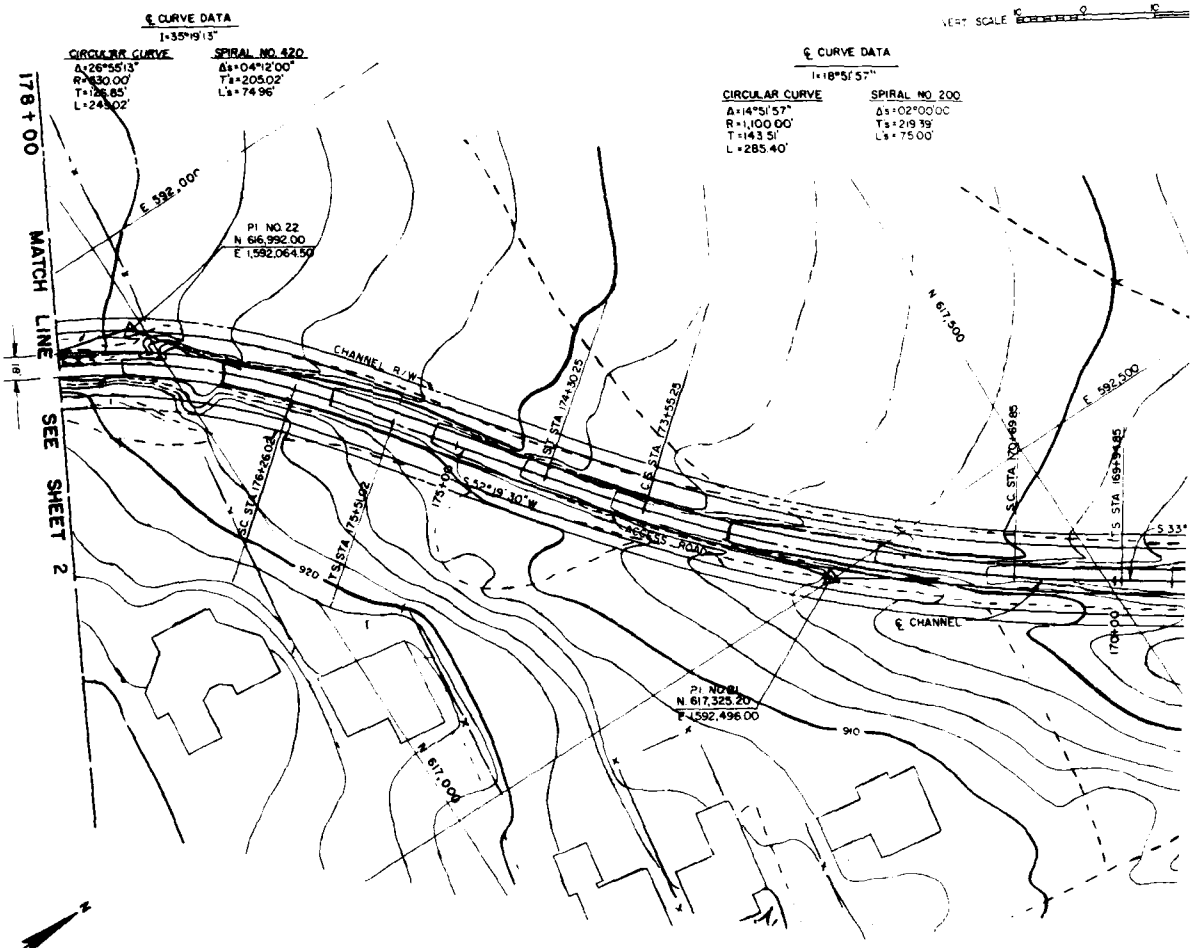
PLATE 4



PROFILE

HORZ. SCALE 50 0 50

VERT SCALE 10 0 10

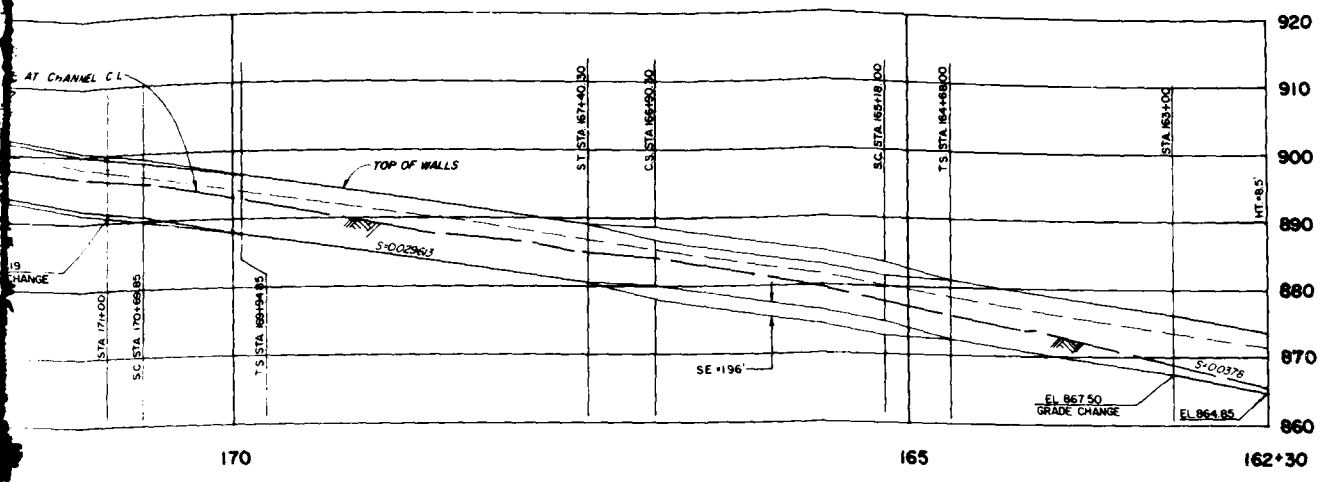


PLAN

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n= 0.014			
						DA	VA	DA	VA
178+00	171+00	18' Rect.	.028540	4,400	12.3	6.5	40.8	6.4	41.4
171+00	163+00	18' Rect.	.029613	4,400	12.3	6.4	41.4	6.4	41.9
163+00	162+30	18' Rect.	.037800	4,500	12.5	6.7	40.7	6.8	41.4

LEGEND

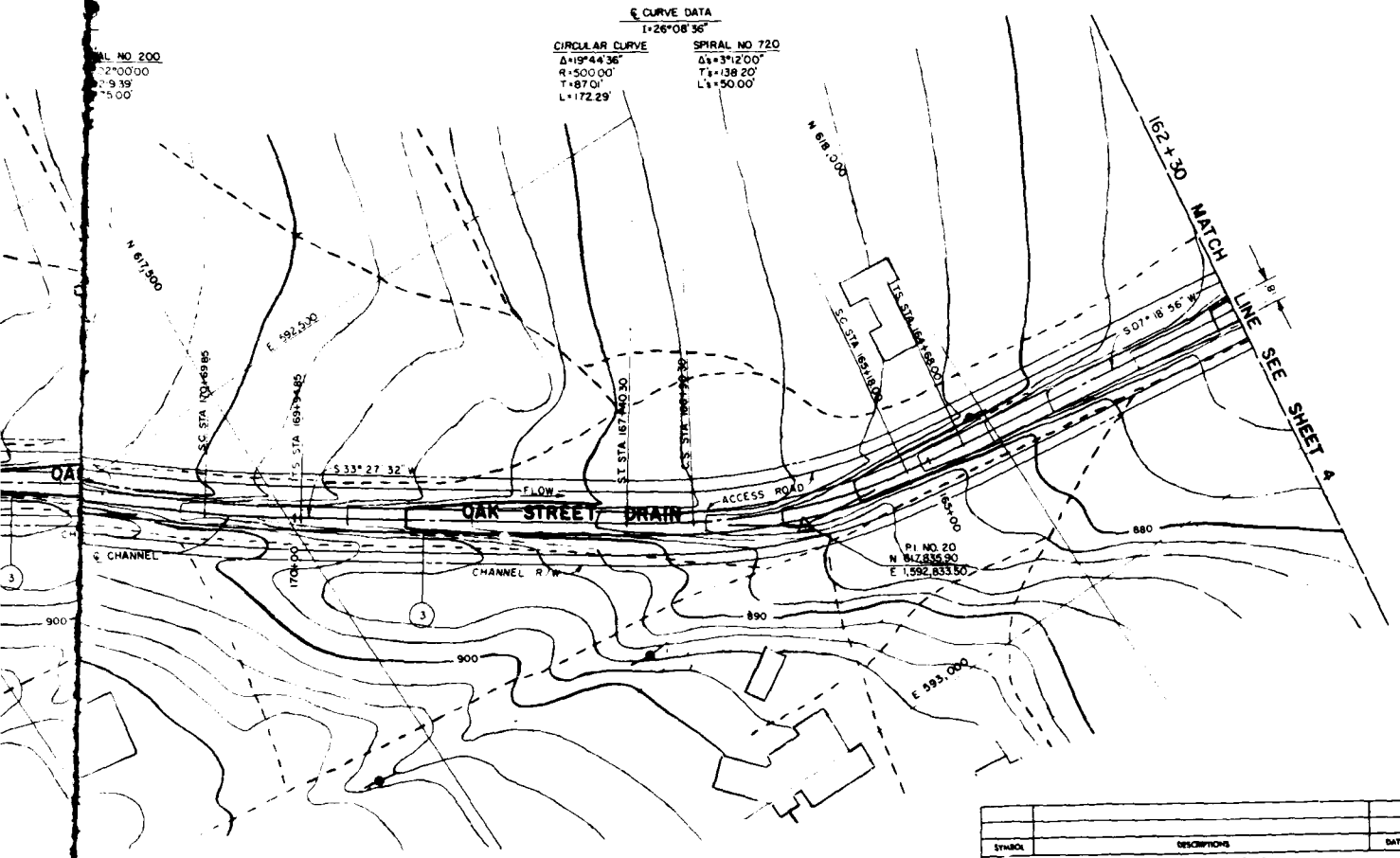
(NO) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2



PROFILE

HORZ SCALE 50 0 50 100 FEET

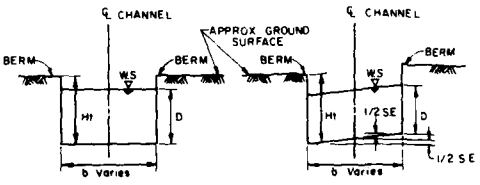
VERT SCALE 0 5 10 20 30 FEET



PLAN

LEGEND

(C) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2a FOR DATA



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA. 178+00 TO STA. 162+30

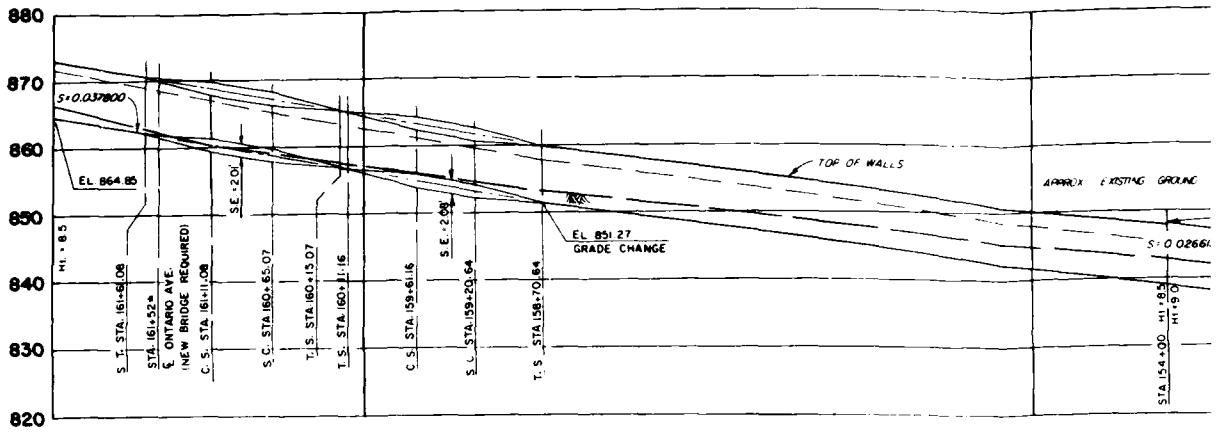
SUBMITTED BY: DATE APPROVED:

SPEC. NO. DACW09-____-____

DISTRICT FILE NO.

SHEET 3 OF 14

PLATE 5



P. I. NO. 19
℄ CURVE DATA
I = 11° 40' 19"

CIRCULAR CURVE	SPIRAL NO 720
Δ = 05° 16' 19"	Δs = 03° 12' 00"
R = 500.00'	Ts = 73.19
T = 23.02'	℄s = 50.00'
℄ = 46.01'	

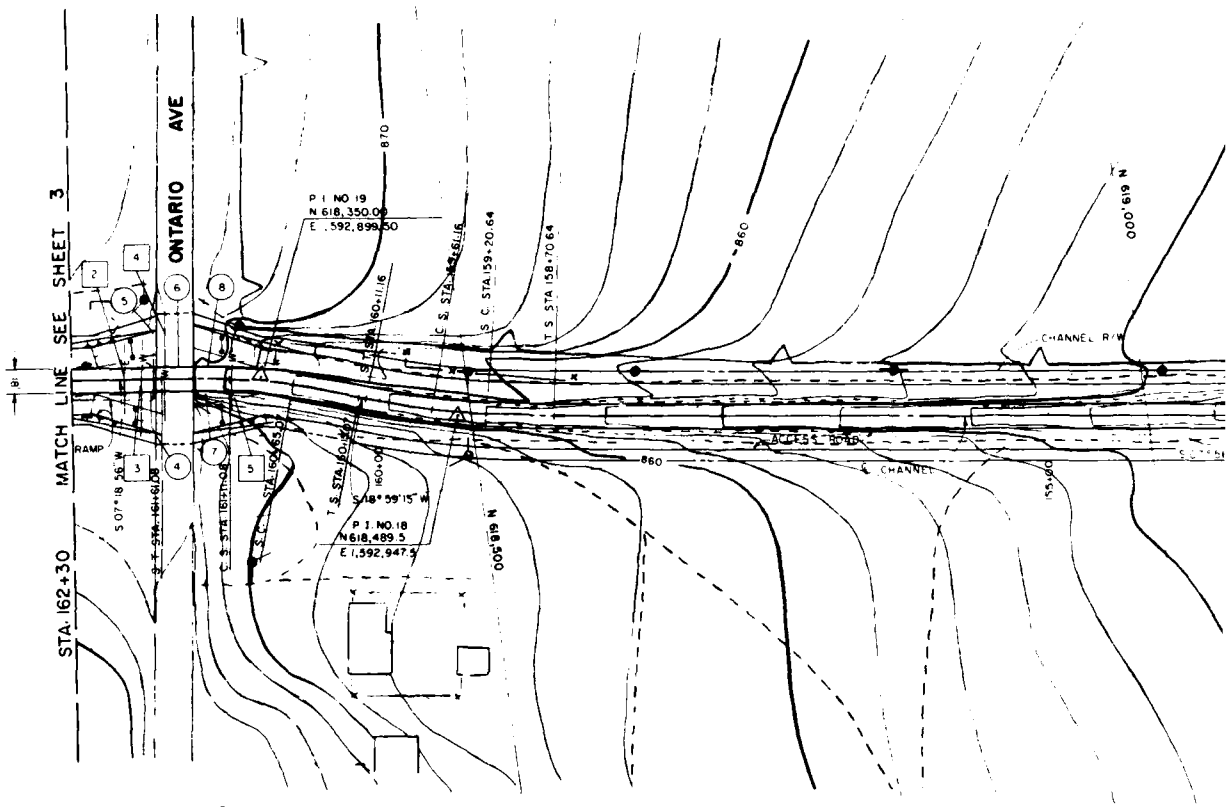
P. I. NO 18
℄ CURVE DATA
I = 11° 02' 35"

CIRCULAR CURVE	SPIRAL NO 720
Δ = 04° 38' 35"	Δs = 03° 12' 00"
R = 500.00'	Ts = 70.42'
T = 20.27'	℄s = 50.00'
℄s = 40.52'	

PROFILE

HORZ SCALE 50 0 50 100

VERT SCALE 5 0 10 20



PLAN

LEGEND

(NO) EXIST UTILITY, SEE TABLE VII-1 FOR DATA

(NO) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2 OR IV-2a FOR DATA

RECOMMENDED DOUBLE DRIVE GATE

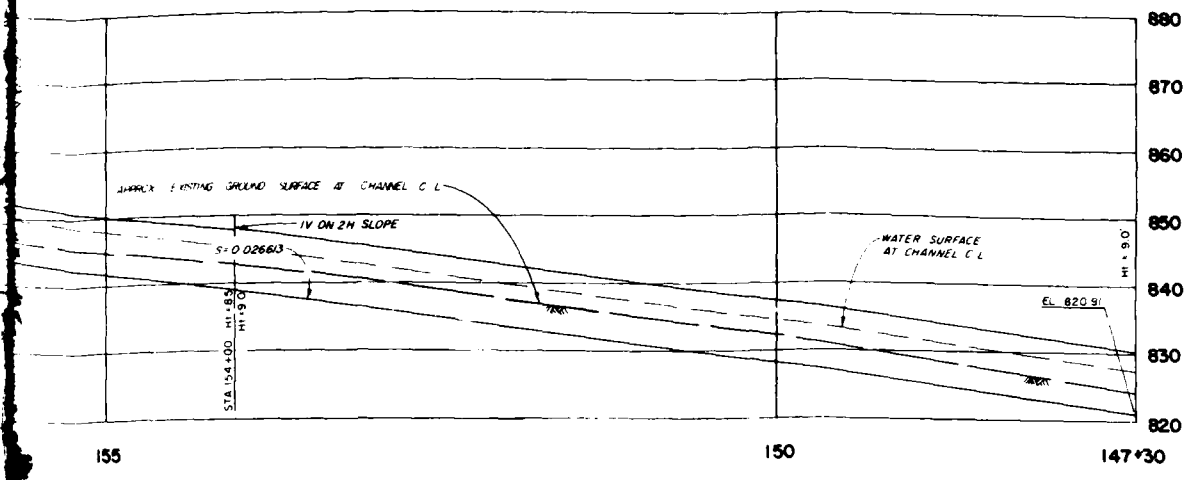
EXISTING POWER POLE

EXISTING DIRT ROAD

N

HYDRAULIC ELEMENTS

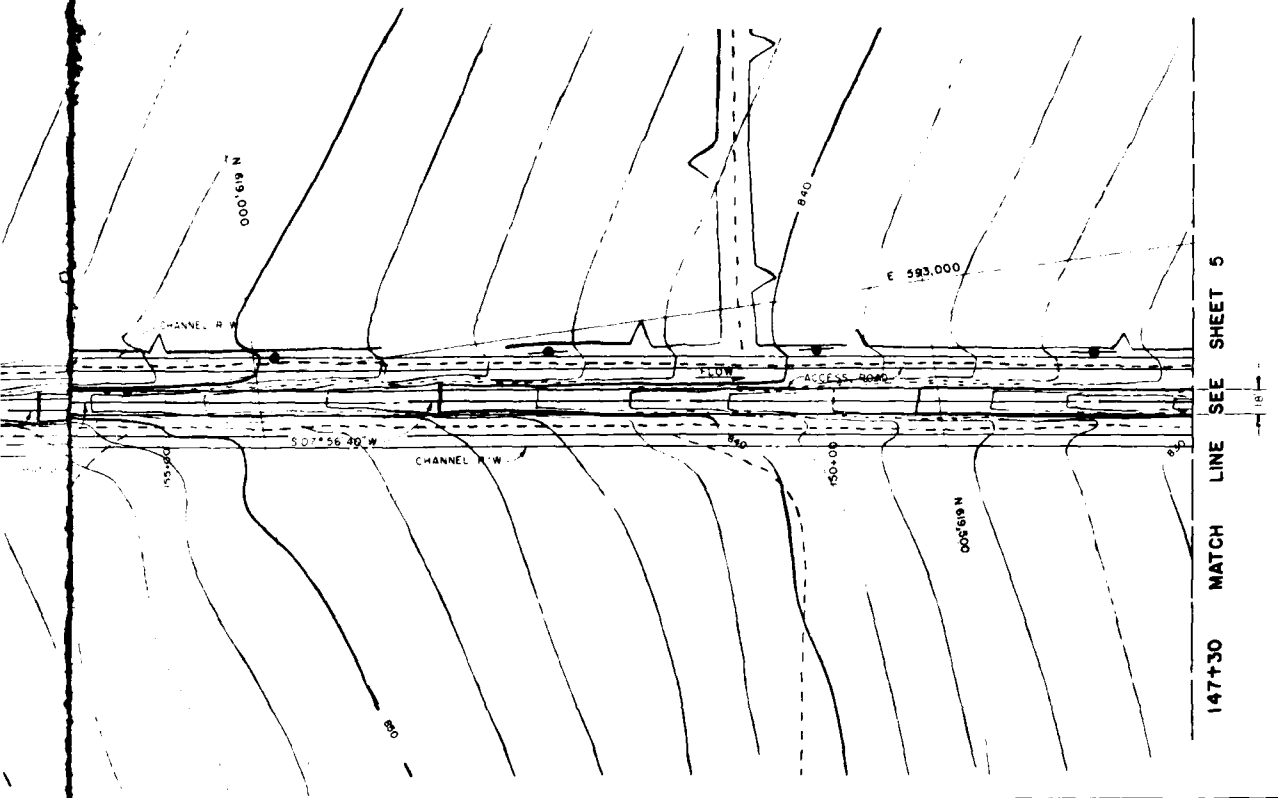
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
162+30	158+70.64	18' Rect.	.037800	4,500	12.5	6.1	40.9	6.3	43.8
158+70.64	158+00	18' Rect.	.026613	4,500	12.5	6.3	43.8	6.3	43.5
158+00	147+30	18' Rect.	.026613	4,500	12.5	6.3	43.5	6.6	41.4



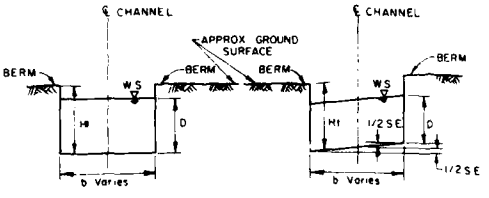
PROFILE

SCALE 50 0 50 100 FEET

30 15 0 30 FEET



PLAN



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RASLAND ENGINEERING
CIVIL ENGINEERING · SURVEYING · LAND PLANNING
9580 SKYPARK STREET, SAN DIEGO, CALIFORNIA, 92123

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY.
DRAWN BY.
CHECKED BY.

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

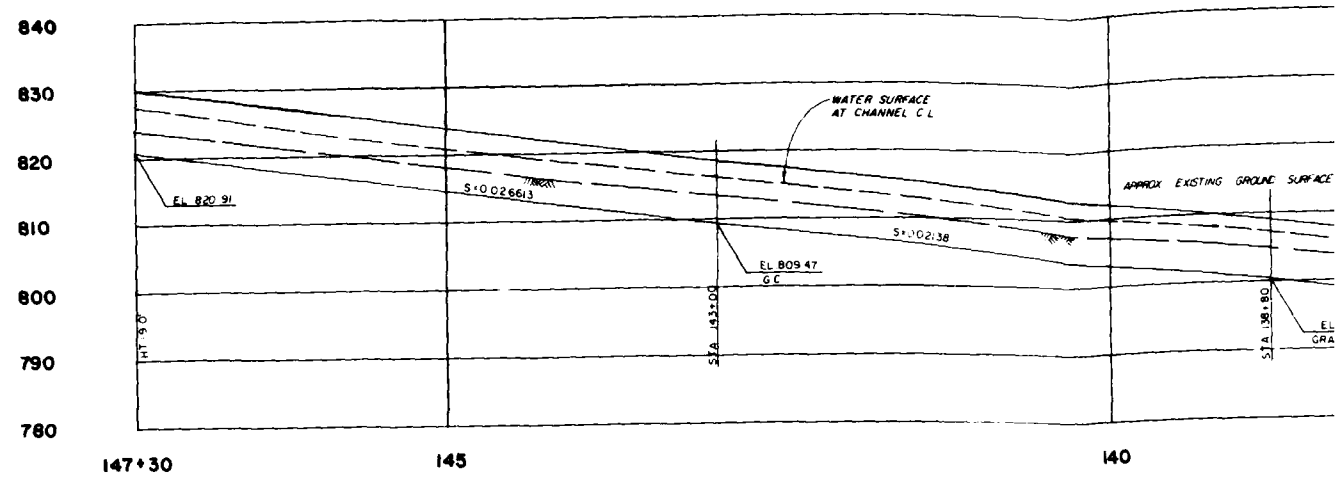
OAK STREET DRAIN
PLAN AND PROFILE
STA 162+30 TO STA 147+30

SUBMITTED BY
DATE APPROVED:
CHIEF, REAL ESTATE

SPEC. NO. DACW09-____-B-____
DISTRICT FILE NO.

SHEET 4 OF 14

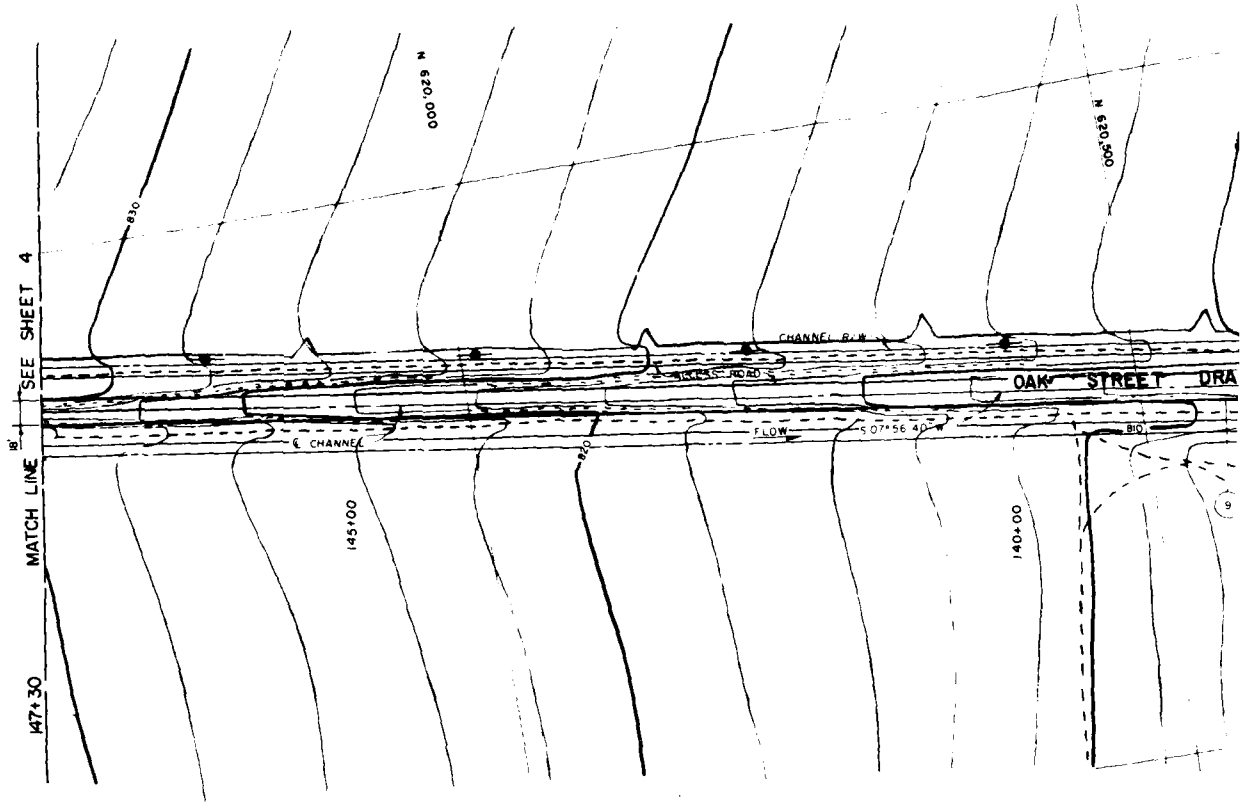
PLATE 6



PROFILE

HORZ SCALE 50 0 50 100 FEET

VERT SCALE 0 10 20 30 FEET



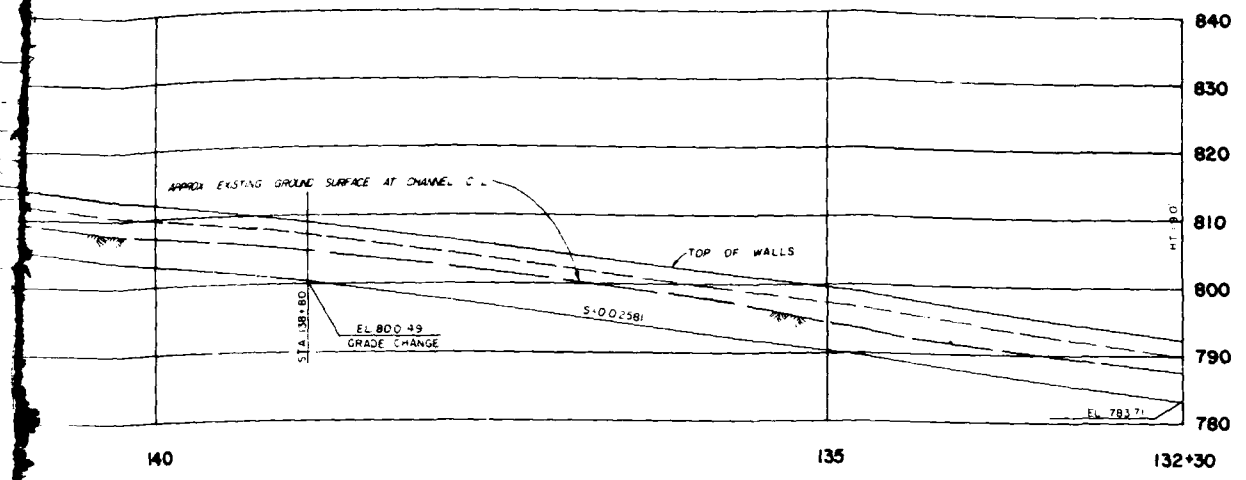
PLAN

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
147+30	143+00	18' Rect.	026613	4,500	12.5	6.6	41.4	6.6	41.3
143+00	138+80	"	021380	"	12.5	6.6	41.3	6.8	39.6
138+80	132+30	"	025810	"	12.5	6.8	39.6	6.7	40.1

LEGEND

(NO) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2 FOR DATA

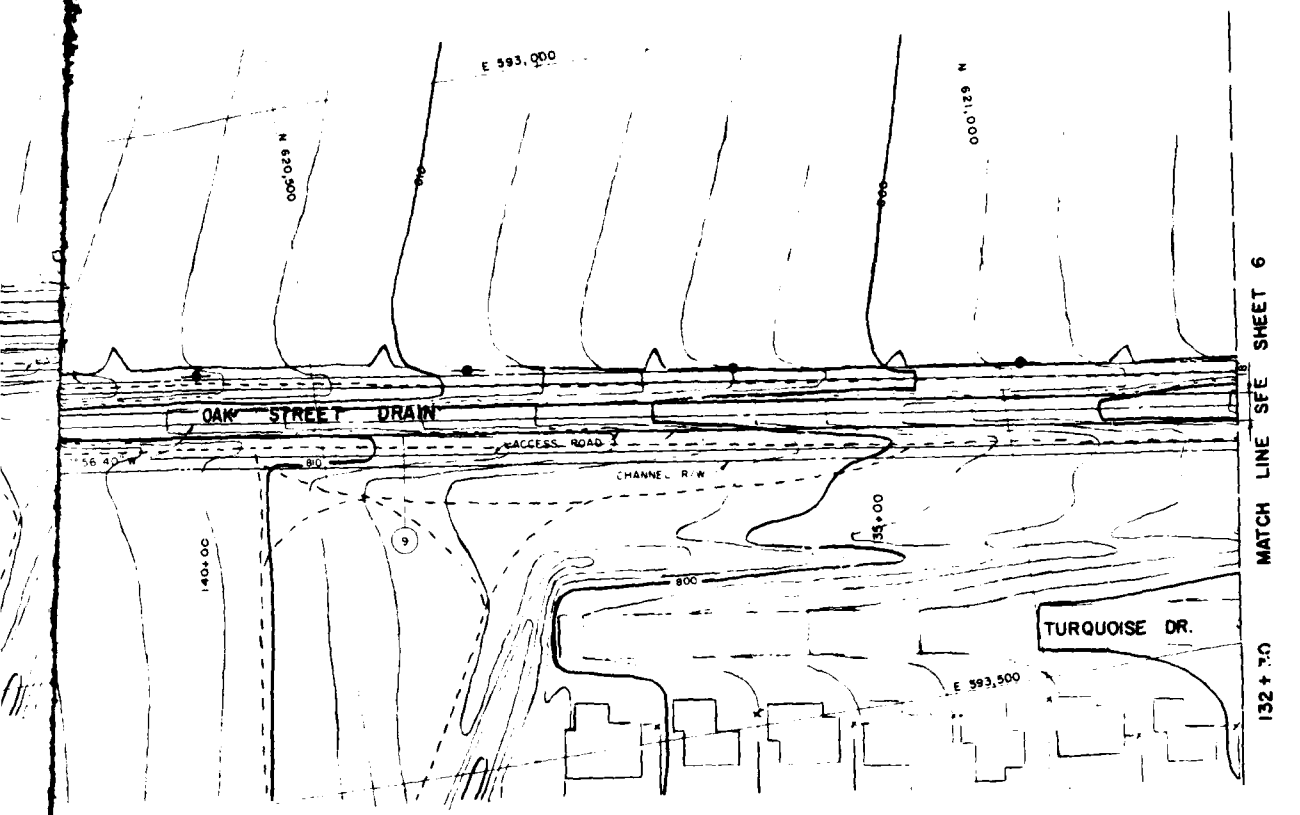
SAFETY PA



PROFILE

SCALE 50 0 50 100 FEET

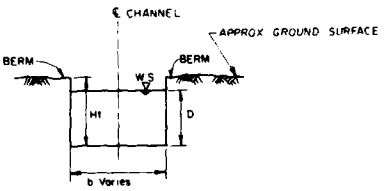
SCALE 10 0 10 20 30 FEET



PLAN

LEGEND

ST SIDE DRAIN LOCATION, SEE TABLE IV-2 FOR DATA



TYPICAL SECTION
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING
CIVIL ENGINEERING · SURVEYING · LAND PLANNING
4000 MACARTHUR STREET, NEWPORT BEACH, CALIFORNIA, 92660

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

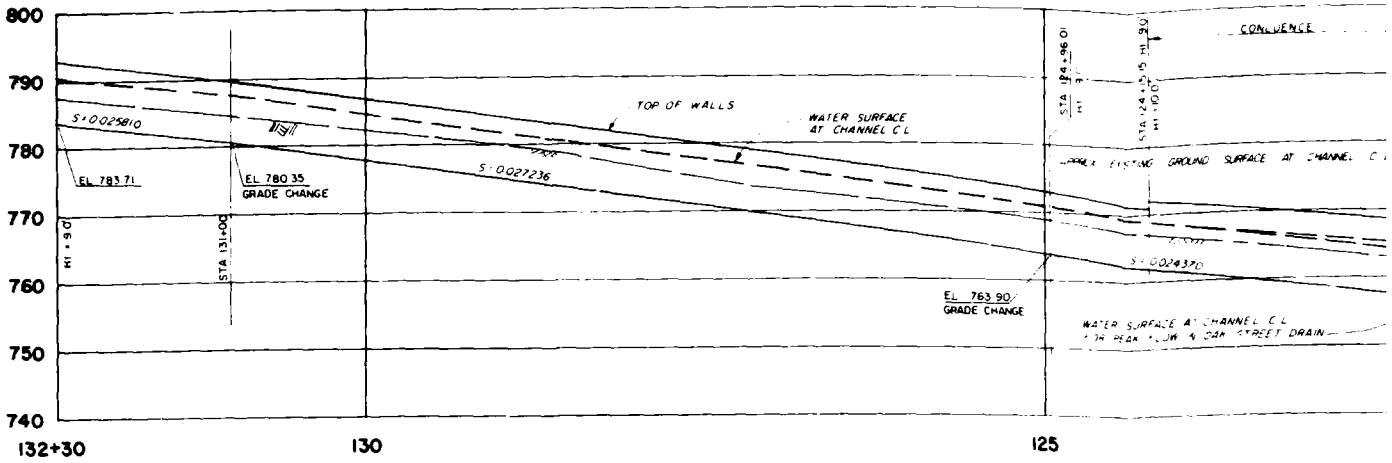
SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA 147 + 30 TO STA 132 +30

SUBMITTED BY: CHIEF, BRANCH
DATE APPROVED:
SPEC. NO. DACW 09- ____ -B- ____
DISTRICT FILE NO.
SHEET 5 OF 14

PLATE 7



HYDRAULIC ELEMENTS

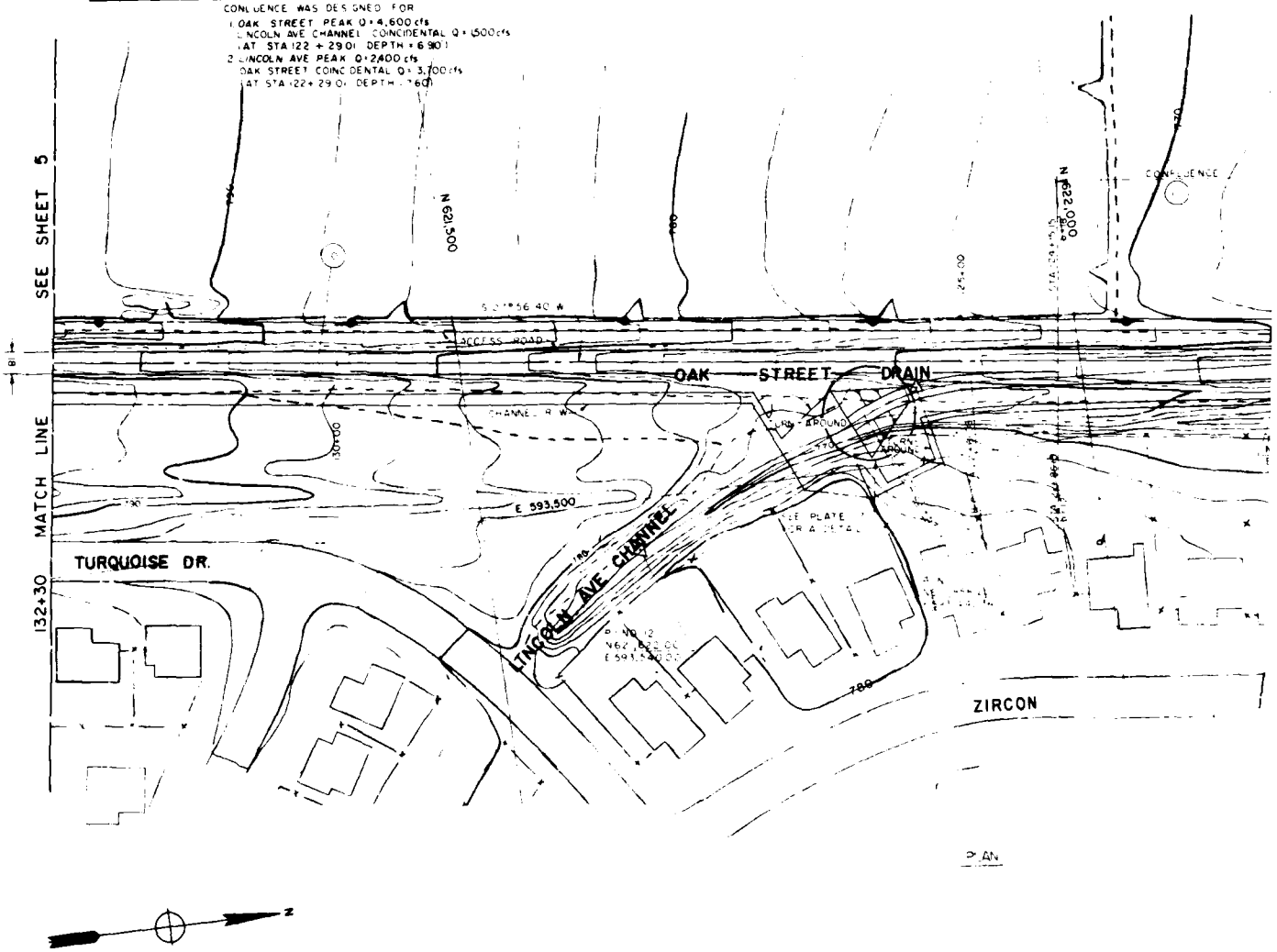
STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
132+30	131+00	18' Rect	025810	4,500	12.5	6.7	40.1	6.7	40.1
131+00	124+96.01	18' Rect	027236	4,600	12.7	7.0	39.0	6.8	40.6
124+96.01	124+15.15	18' Rect	024370	4,600	12.7	6.8	40.6	6.8	40.6
124+15.15	122+29.01	CONFL	"	Varies	—	6.8	40.5	7.6	34.8
122+29.01	118+20	24' Rect	"	6,100	12.6	7.6	34.8	7.1	38.2
118+20	117+70	Trans	"	6,100	Varies	7.1	38.2	6.5	38.9
117+70	117+40	26' Rect	"	6,100	12.0	6.5	38.9	6.5	38.9

CONFLUENCE WAS DESIGNED FOR
1. OAK STREET PEAK Q = 4,600 cfs
LINCOLN AVE CHANNEL COINCIDENTAL Q = 1,500 cfs
AT STA 122 + 29.01 DEPTH = 6.80'
2. LINCOLN AVE PEAK Q = 2,400 cfs
OAK STREET COINCIDENTAL Q = 3,700 cfs
AT STA 122+29.01 DEPTH = 7.60'

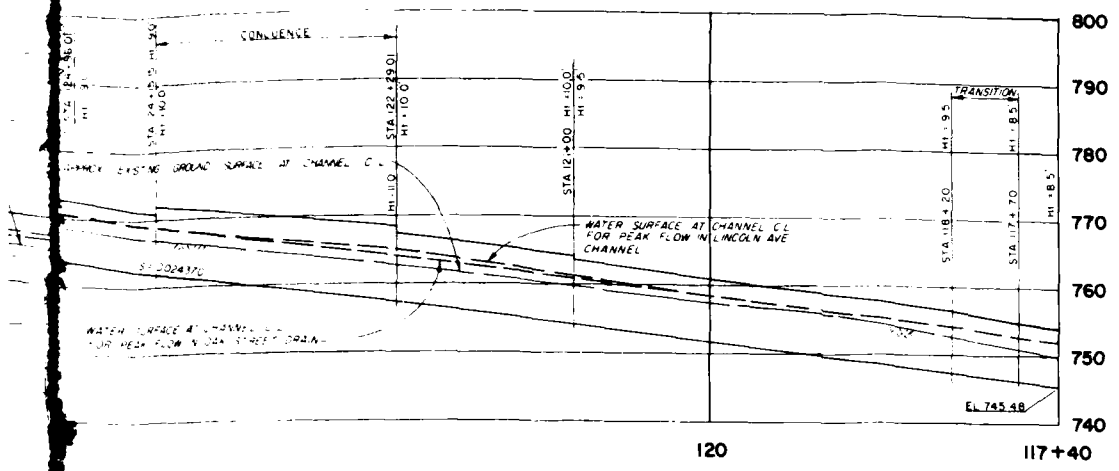
PROFILE

HORIZ SCALE 50 0 50 100 FEET

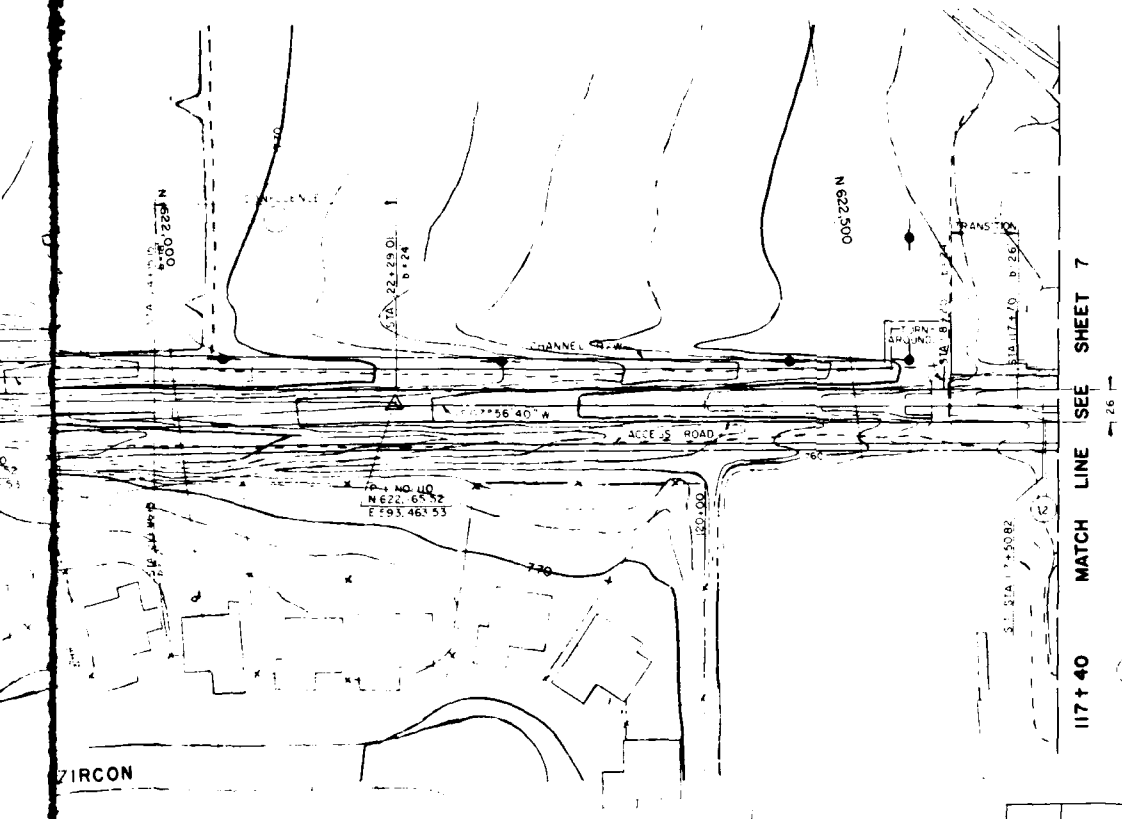
VERT SCALE 0 5 10 FEET



SAFETY PA



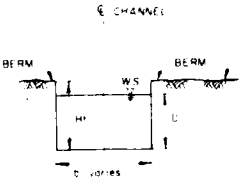
PROFILE



ZIRCON

LEGEND

(NO) EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2 OR IV-2a FOR DATA



TYPICAL SECTION

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING
CIVIL ENGINEERING SURVEYING LAND PLANNING
1455 HOFFNER STREET SAN DIEGO CALIFORNIA 92111

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

SANTA ANA RIVER MAINSTEM, CALIFORNIA

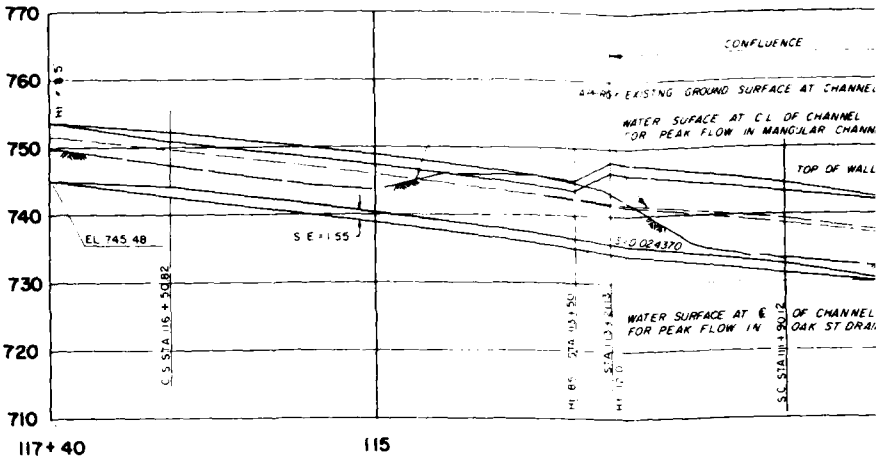
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA 132+30 TO STA 117+40

SUBMITTED BY
DATE APPROVED
SPEC NO DACW09-
DISTRICT FILE NO
SHEET

SAFETY PAYS

PLATE 8



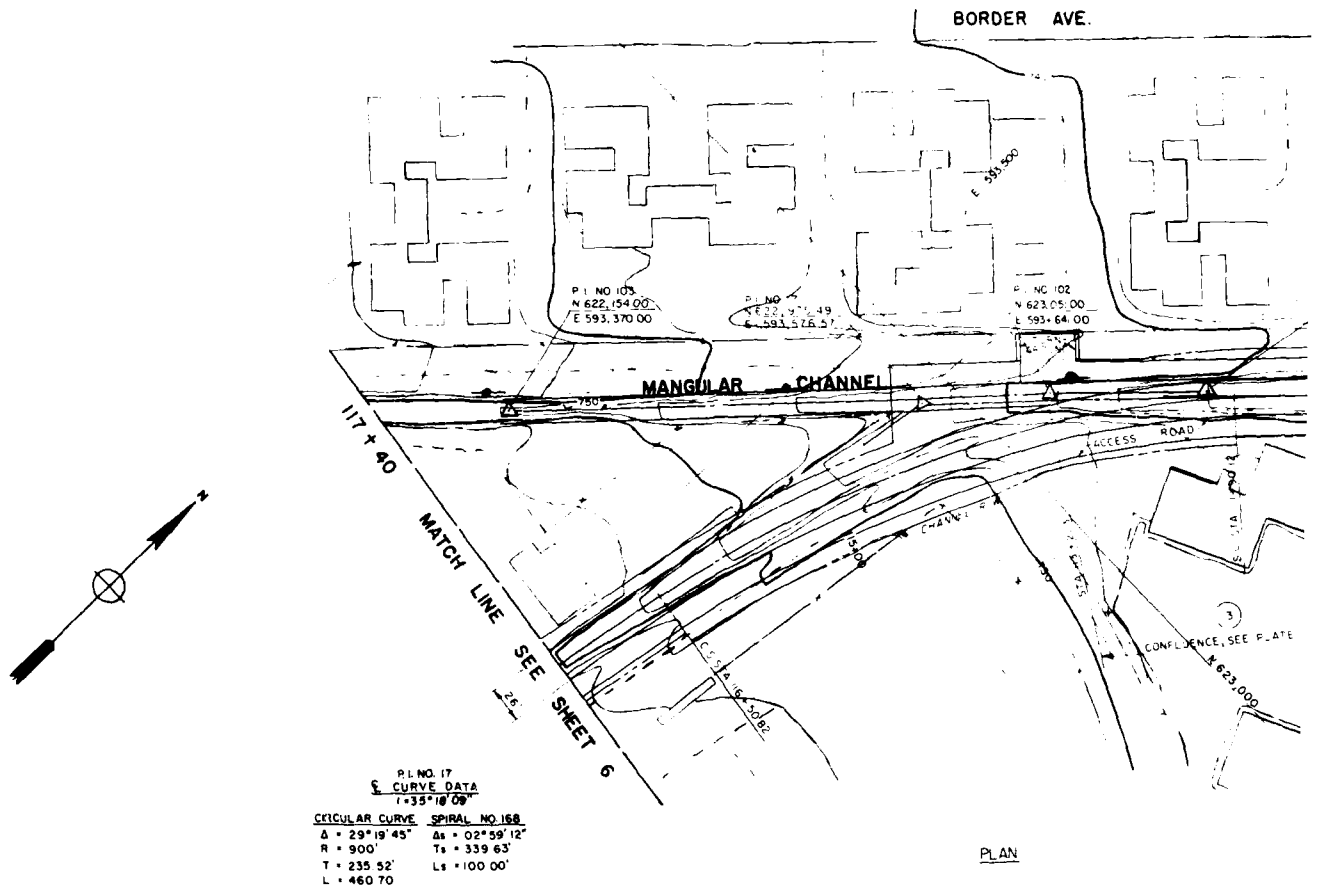
PROFILE

HORIZ SCALE 1" = 100' FEET

VERT SCALE EXAGGERATED 10 X FEET

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
117 + 40	113+21.13	26'Rect.	.024370	6100	12.0	6.5	38.9	6.3	40.1
113+21.13	111 + 90.12	Contl.	.024370	Varies	—	6.3	40.1	7.7	37.1
111 + 90.12	109+.19	26' Rect.	.024370	7100	13.2	7.7	37.1	7.4	39.2

Confuence was designed for
1 Oak Street Drain Peak Q = 6100 cfs
Mangular Channel Coinc Q = 1000 cfs
(At Sta 111 + 90.12 Depth = 7.40')
2 Mangular Channel Peak Q = 700 cfs
Oak Street Drain Coinc Q = 5400 cfs
(At Sta 111 + 90.12 Depth = 7.77')

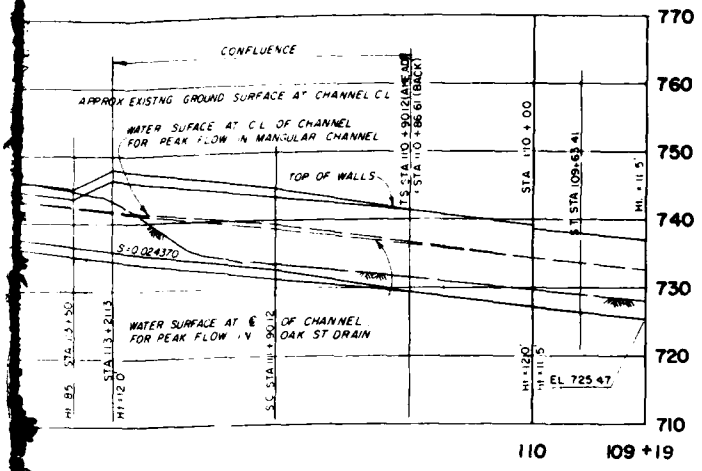


P.I. NO. 17
℄ CURVE DATA
I = 35° 18' 09"

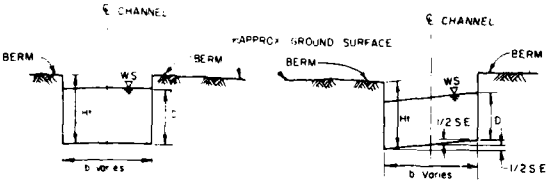
CIRCULAR CURVE	SPIRAL NO. 168
Δ = 29° 19' 45"	Δs = 02° 59' 12"
R = 900'	Ts = 339.63'
T = 235.52'	Ls = 100.00'
L = 460.70	

PLAN

SAFETY P



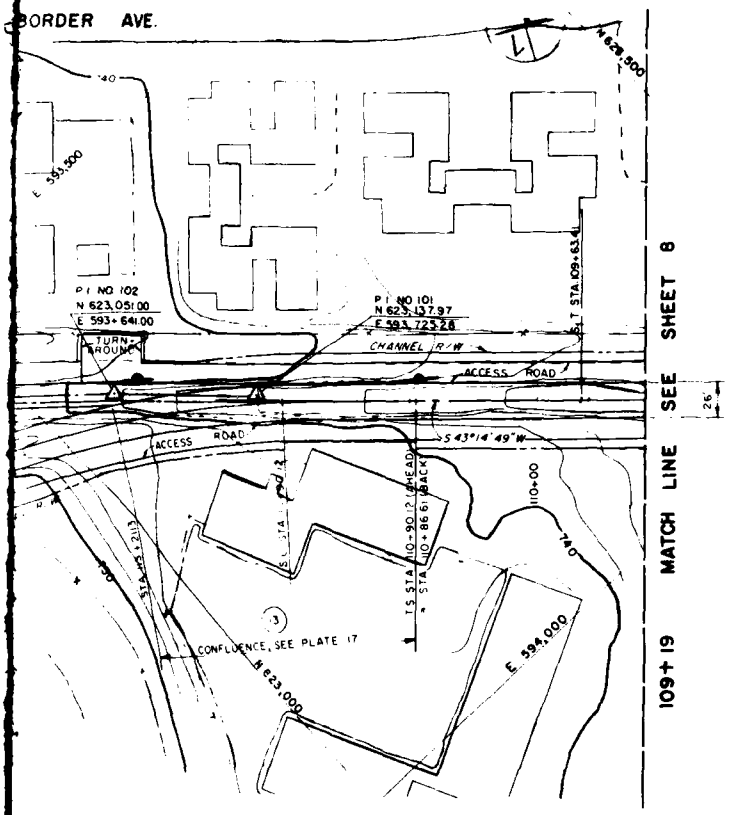
PROFILE



SECTION ON TANGENT

SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE



PLAN

LEGEND

(40) EX ST. SIDE DRAIN LOCATION, SEE TABLE IV-26 FOR DATA

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING
CIVIL ENGINEERING SURVEYING LAND PLANNING
4695 CHESTNUT STREET, SUITE 21000, CALIFORNIA, 92651

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

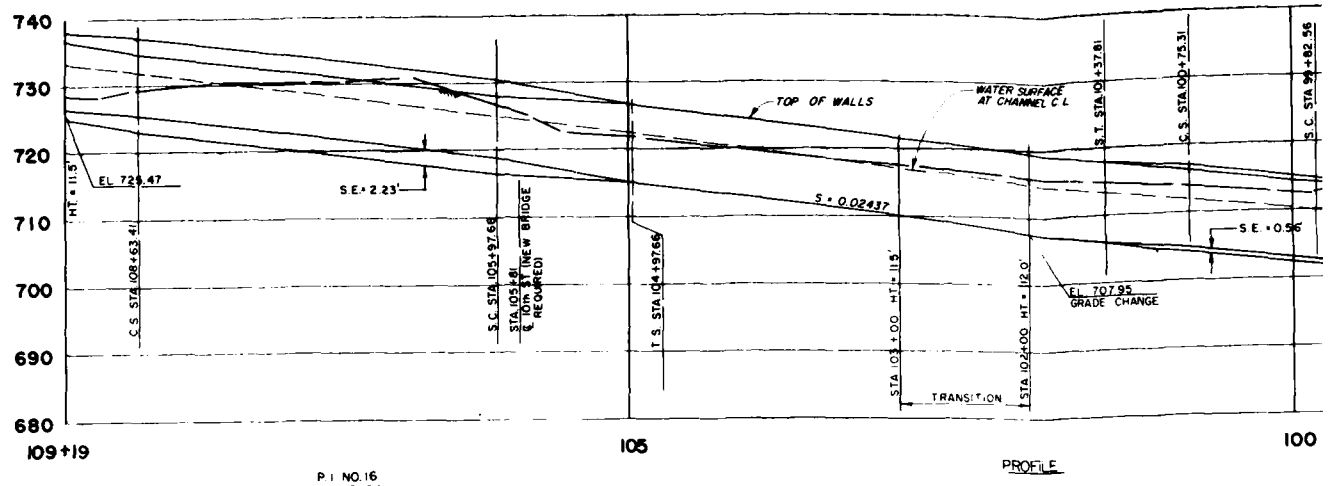
PLAN AND PROFILE

STA. 117+40 TO STA. 109+19

SUBMITTED BY:
DATE APPROVED:
CHIEF, ENGINEERING DIVISION

SPEC. NO. DACW09- ____ -B- ____
DISTRICT FILE NO.

SHEET 7 OF 14



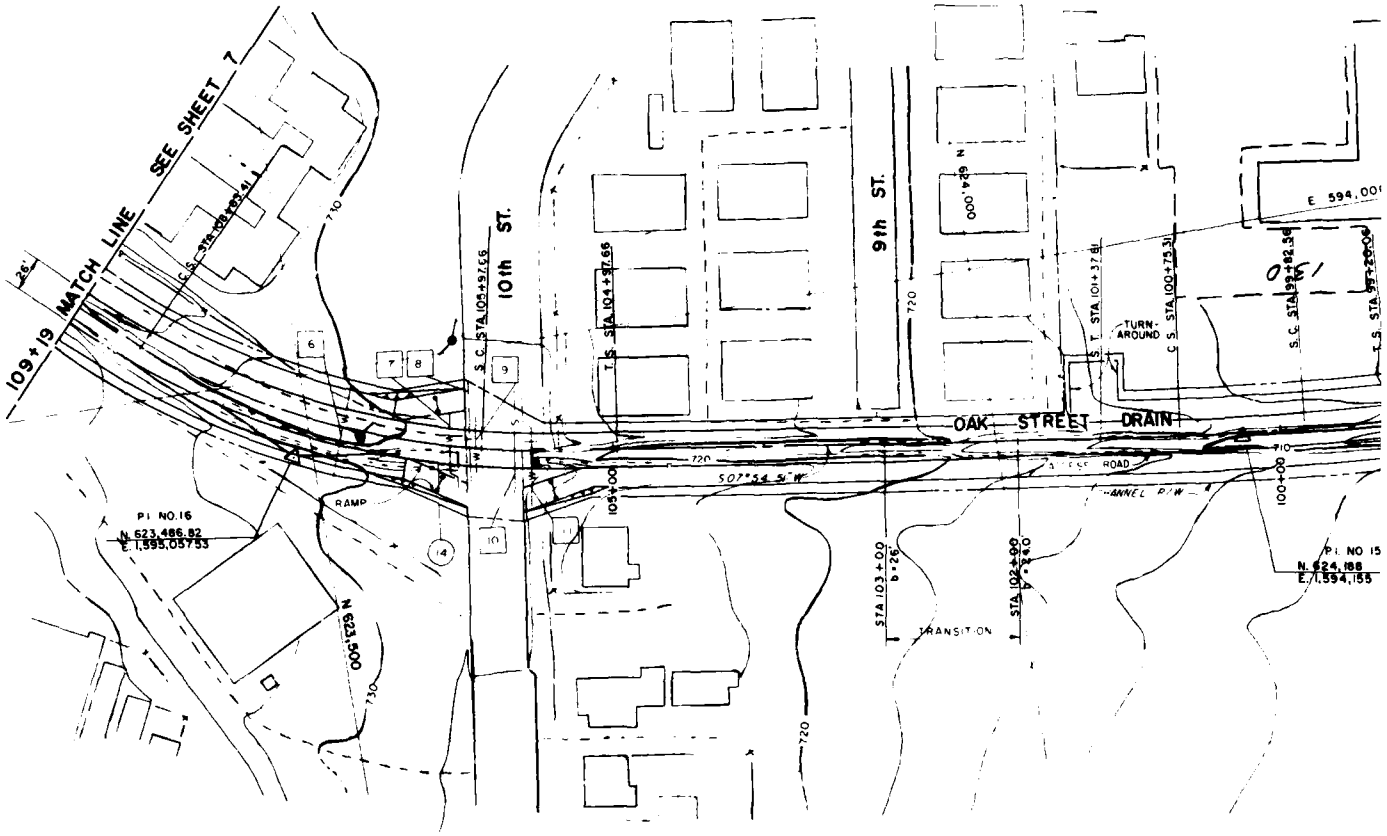
PROFILE

HORIZ SCALE 50 0 50 100 FEET

VERT SCALE 10 0 10 20 30 FEET

P I NO 16
℄ CURVE DATA
I = 35° 19' 58"

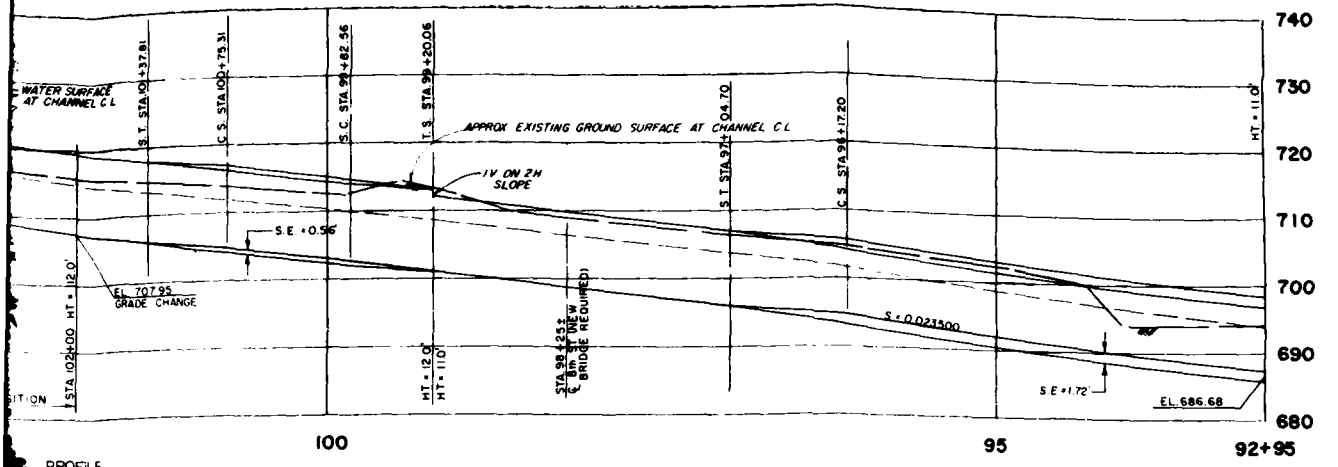
CIRCULAR CURVE	SPIRAL NO 280
Δ = 25° 22' 38"	Δ_s = 04° 58' 40"
R = 600.00'	T_s = 239.16'
T = 135.09'	L_s = 100.00'
L = 265.75'	



PLAN

SECTION

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
109+19	103+00	26' Rect.	.024370	7,100	11.7	7.4	39.2	7.1	41.6
103+00	102+00	Trans.	.024370	7,100	Varies	7.1	41.6	7.7	41.4
102+00	92+95	24' Rect	.023500	"	13.4	7.7	41.4	7.5	42.9



PROFILE

0 50 100 FEET

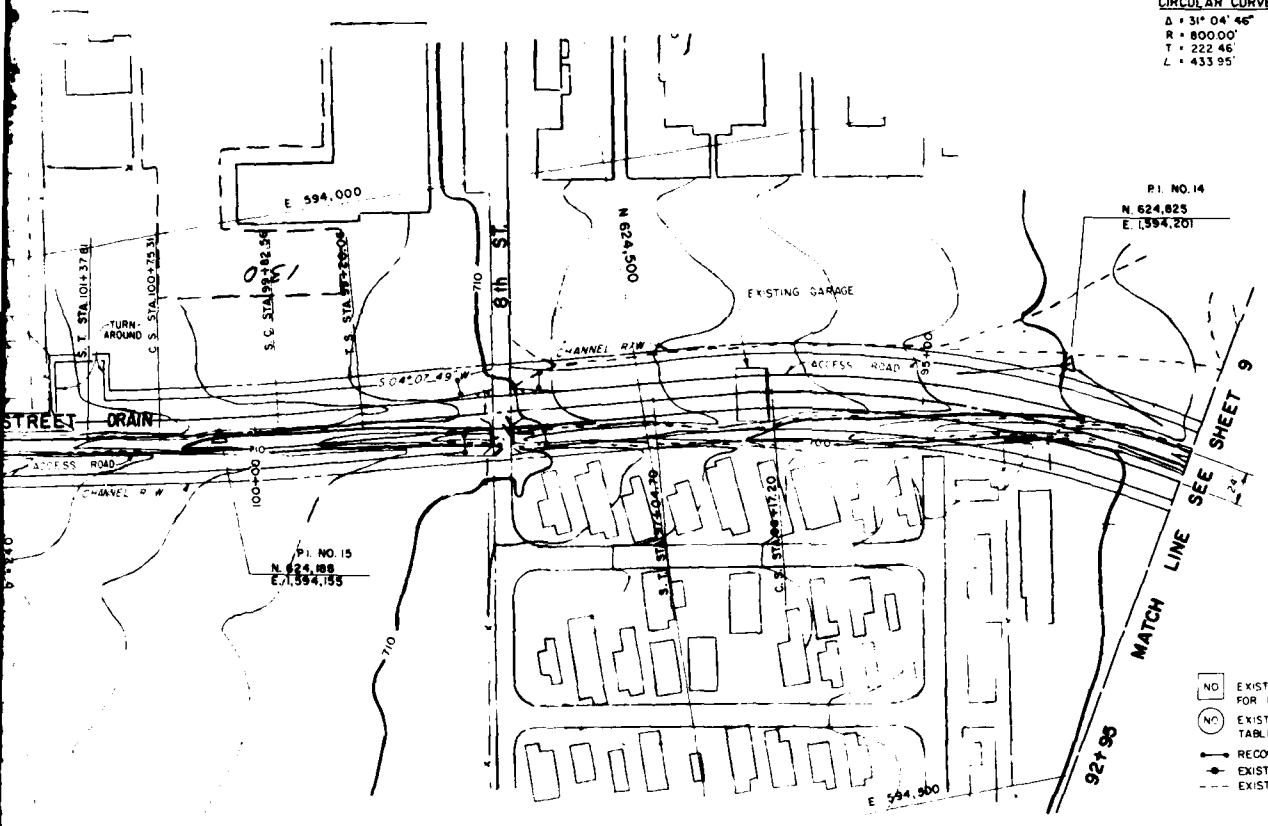
0 20 30 FEET

P.I. NO 15
℄ CURVE DATA
I = 03° 47' 01"

CIRCULAR CURVE	SPIRAL NO.113
Δ = 02° 12' 51"	Δ_s = 00° 47' 05"
R = 2,400'	T_s = 108.90'
T = 46.38'	L_s = 62.5'
L = 92.75'	

P.I. NO.14
℄ CURVE DATA
I = 37° 31' 52"

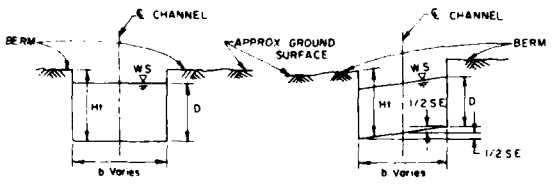
CIRCULAR CURVE	SPIRAL NO.237
Δ = 31° 04' 46"	Δ_s = 03° 13' 33"
R = 800.00'	T_s = 314.39'
T = 222.46'	L_s = 87.50'
L = 433.95'	



PLAN

LEGEND

- (NO) EXIST. UTILITY, SEE TABLE VII-1 FOR DATA
- (NO) EXIST. SIDE DRAIN LOCATION, SEE TABLE IV-2 FOR DATA
- RECOMMENDED DOUBLE DRIVE GATE
- EXISTING POWER POLE
- EXISTING DIRT ROAD



TYPICAL SECTIONS
NOT TO SCALE

14			
A	VA		
1	41.6		
7	41.4		
5	42.9		

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RASLAND ENGINEERING
CIVIL ENGINEERING SURVEYING LAND PLANNING
4660 KENDALL STREET, SAN DIEGO, CALIFORNIA, 92123

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA. 109+19 TO STA. 92+95

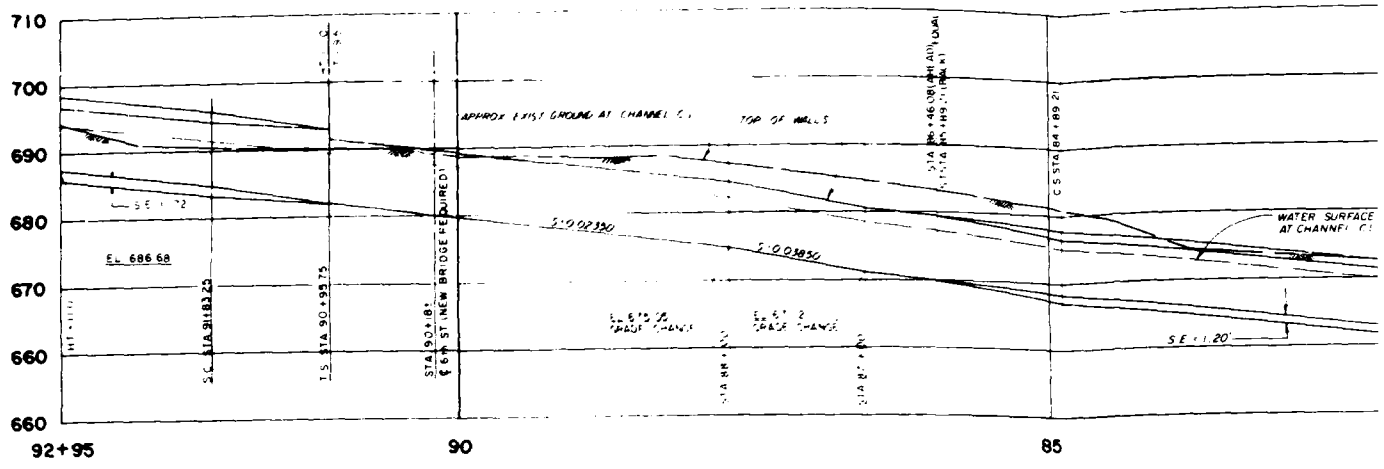
SUBMITTED BY: DATE APPROVED:

CHIEF, BRANCH

SPEC. NO. DACW09-____-B-____
DISTRICT FILE NO.

SHEET 8 OF 14

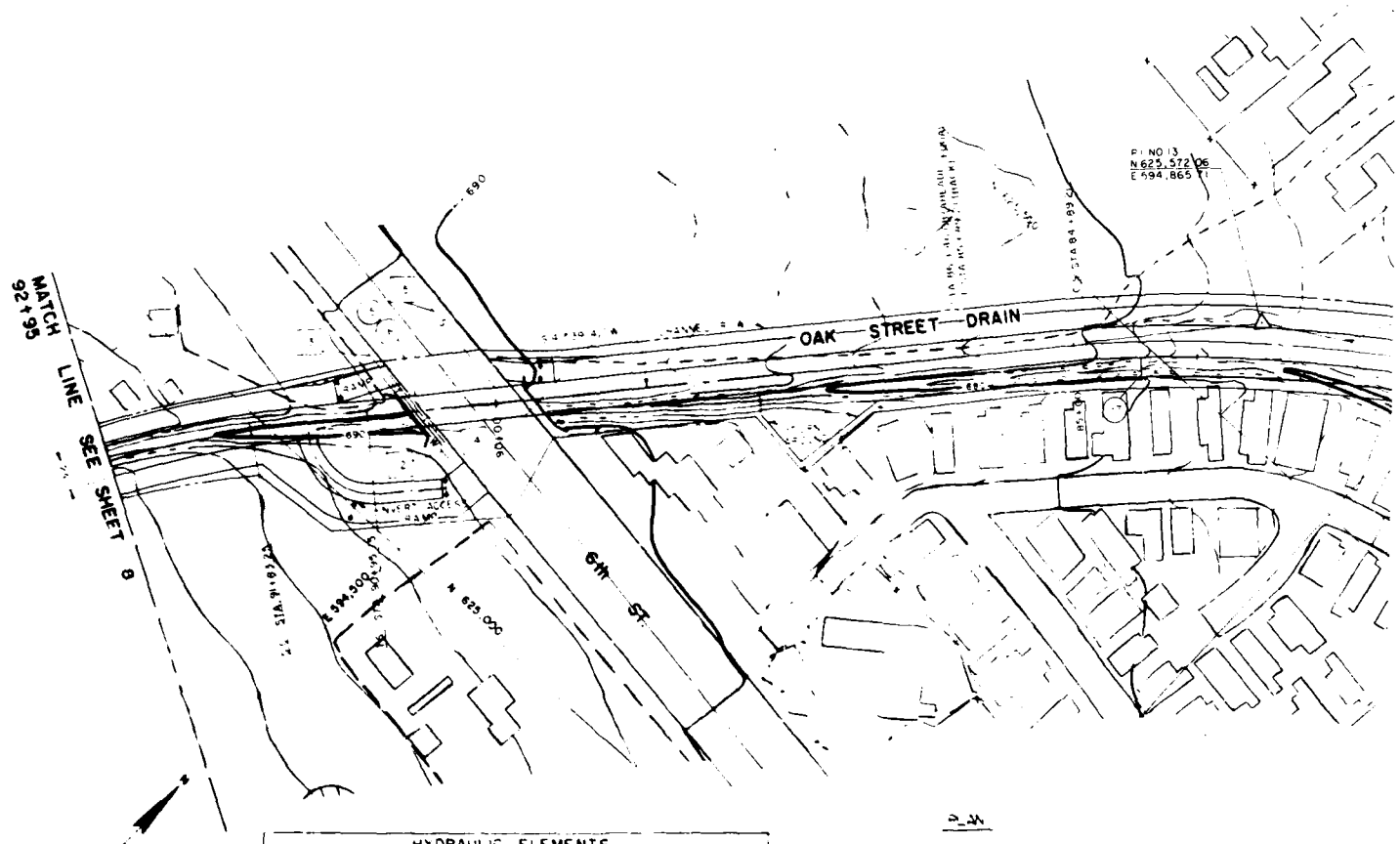
PLATE 10



PROFILE

HORIZ. SCALE 1" = 50' FEET

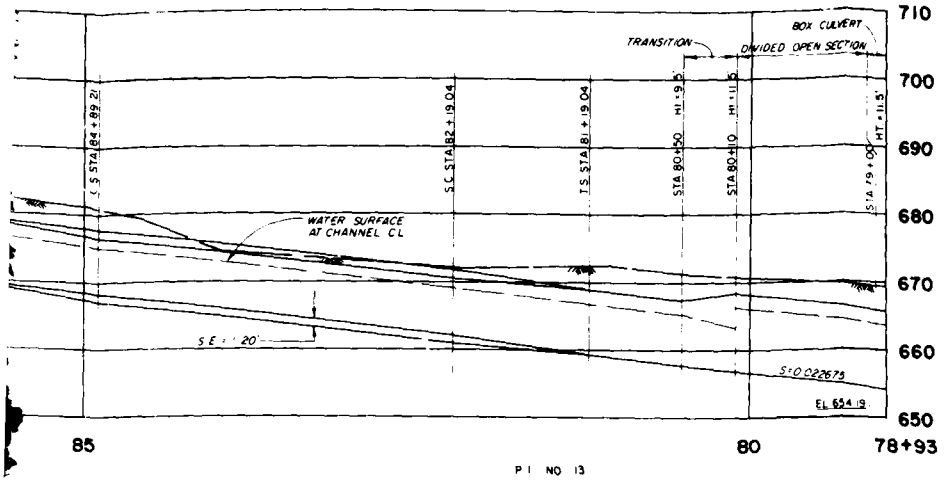
VERT. SCALE 1" = 10' FEET



PLAN

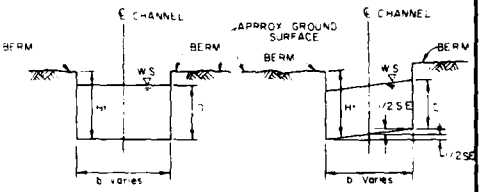
HYDRAULIC ELEMENTS										
STA	TO STA	SECTION	SLOPE	Q	D_c	D_n	n=0.014 V_c	V_n	n=0.013 V_c	V_n
92+95	88+30	24 Rect	.02350	1100	4.0	1.5	42.9	7.4	45.2	
88+00	87+00	24 Rect	.03850	1100	4.0	1.4	49.2	7.5	44.2	
87+00	*86+46.08	24 Rect	.022675	1100	4.0	1.5	44.2	7.3	44	
*85+89.21	80+50	24 Rect	.022675	1100	4.0	1.5	44	7.4	43.4	
80+50	80+10	TRANS	.022675	1100	VARIES	1.4	43.4	6.4	44	
80+10	79+50	28 Rect	.022675	1100	2.9	6.4	44	9.0	29.4	
79+50	79+00	28 Rect	.022675	1100	2.9	6.0	29.4	8.8	30.2	
79+00	78+93	BOX	.022675	1100	2.9	8.8	30.2	--	35.8	

* EQUATION STATION



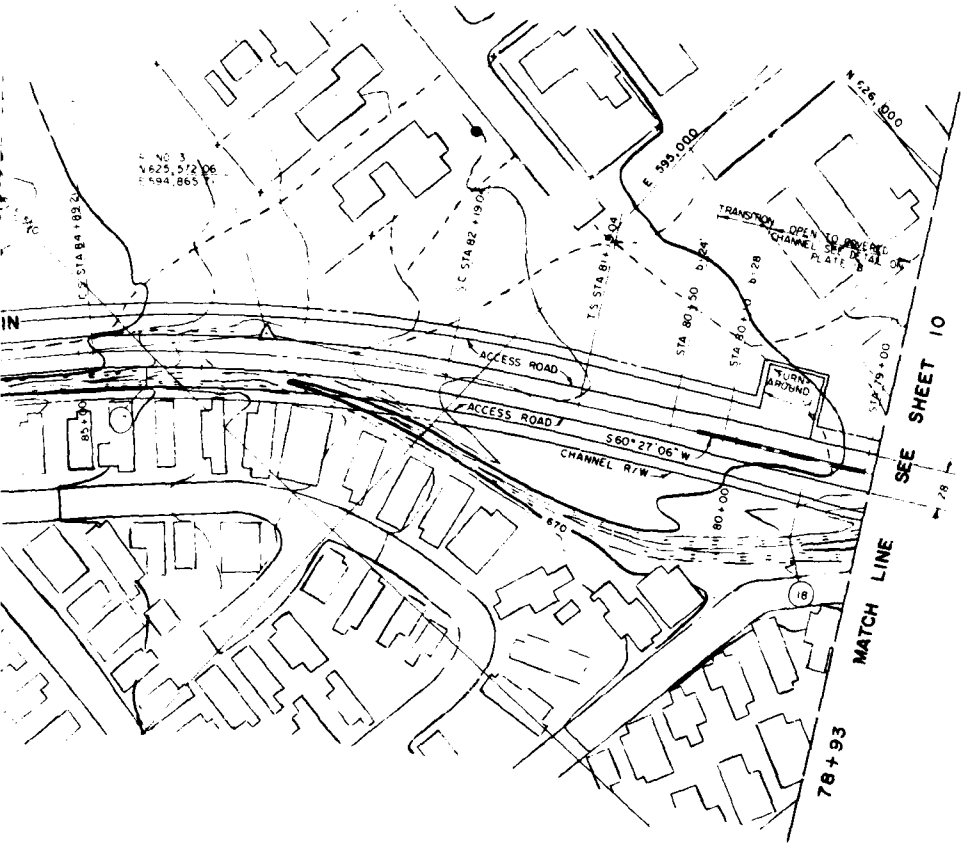
P I NO 13
℄ CURVE DATA
I=17° 50' 30"

CIRCULAR CURVE	SPIRAL NO 139
Δ=12° 53' 58"	Δ_s=02° 28' 16"
R=1200 00'	T_s=236 66
T=135 66	L_s=100 00'
L=270 17'	



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE



LEGEND

- NO — EXIST UTILITY, SEE TABLE VII-1 FOR DATA
- (NO) — EXIST SIDE DRAIN LOCATION, SEE TABLE IV-2 OR IV-2a FOR DATA
- RECOMMENDED DOUBLE DRIVE GATE
- EXISTING POWER POLE
- EXISTING DIRT ROAD

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RAILAND ENGINEERING
CIVIL ENGINEERING · SURVEYING · LAND PLANNING
9300 JEFFERSON STREET, SAN PEDRO, CALIFORNIA, 90111

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

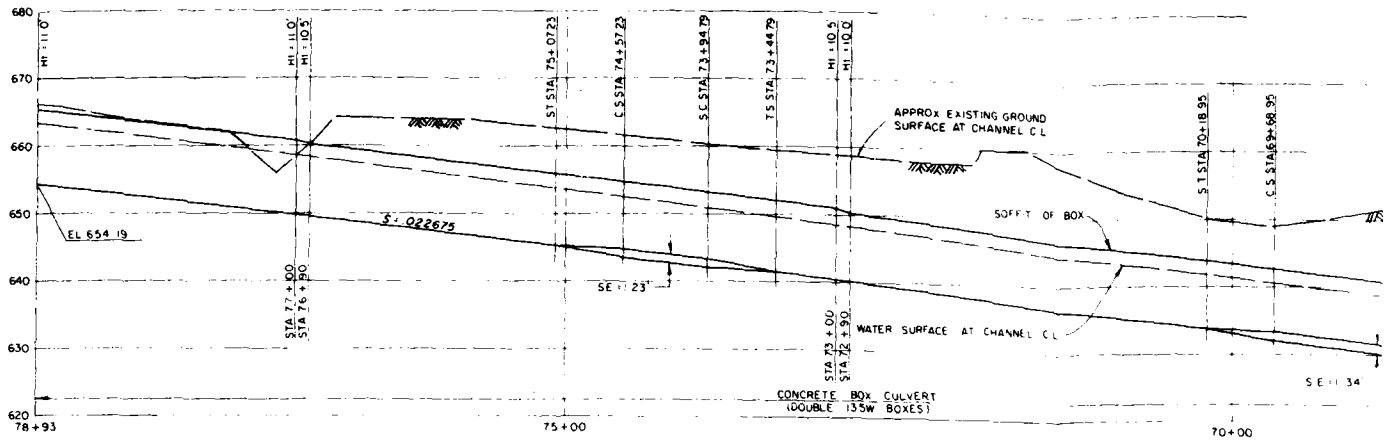
OAK STREET DRAIN
PLAN AND PROFILE
STA. 92+95 TO STA. 78+93

SUBMITTED BY: DATE APPROVED:
CHIEF, BRANCH

SPEC. NO. DACW09-____-B-____
DISTRICT FILE NO.

SHEET 9 OF 14

PLATE 11

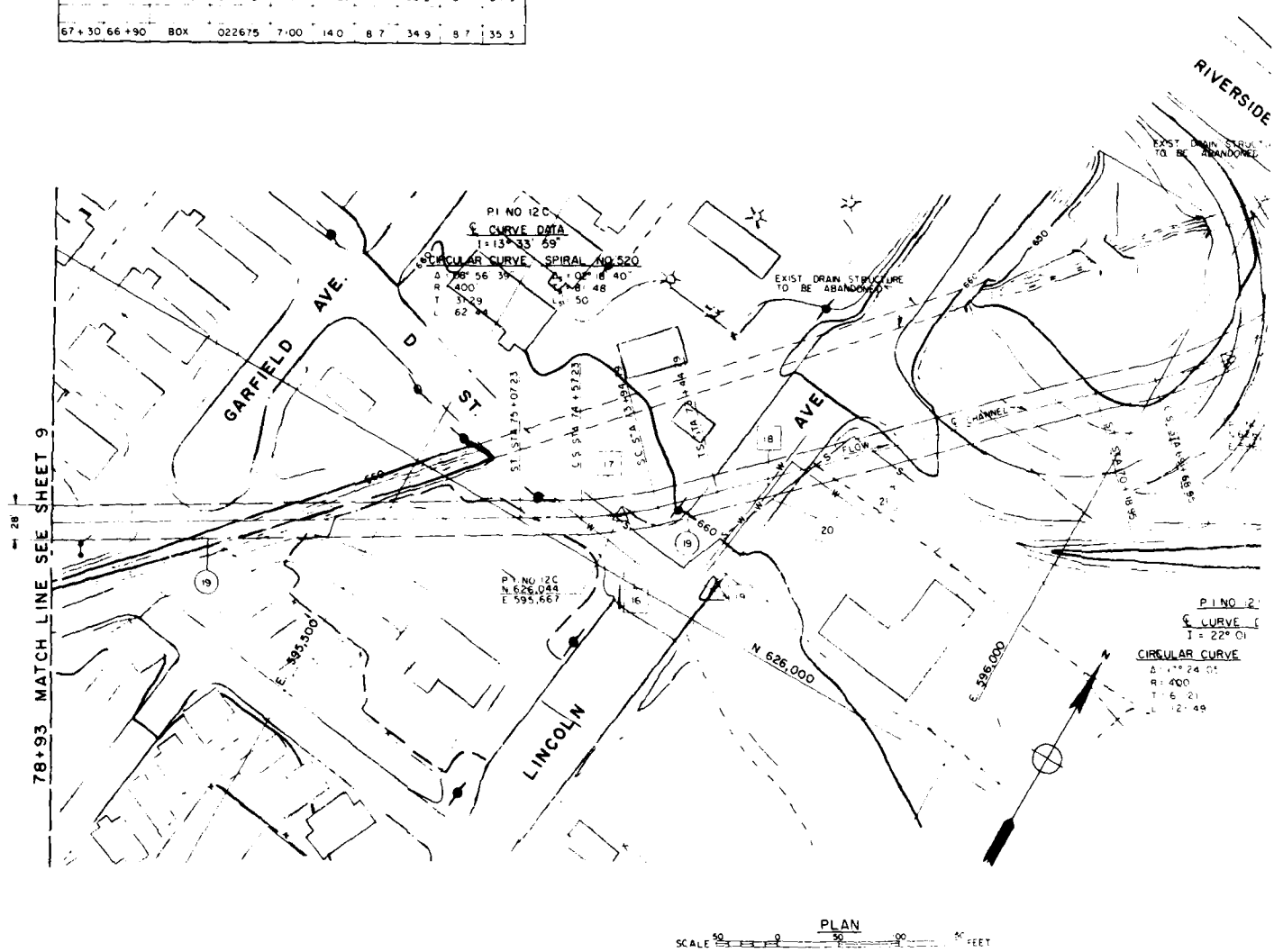


PROFILE

HORIZ SCALE 50 0 50 100 150 FEET

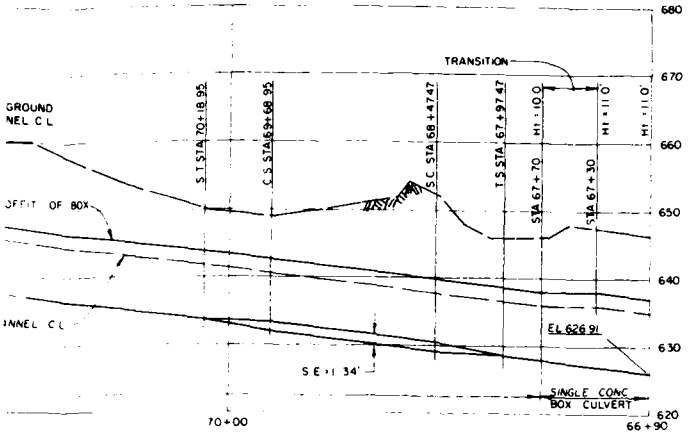
VERT SCALE 10 0 10 1 FEET

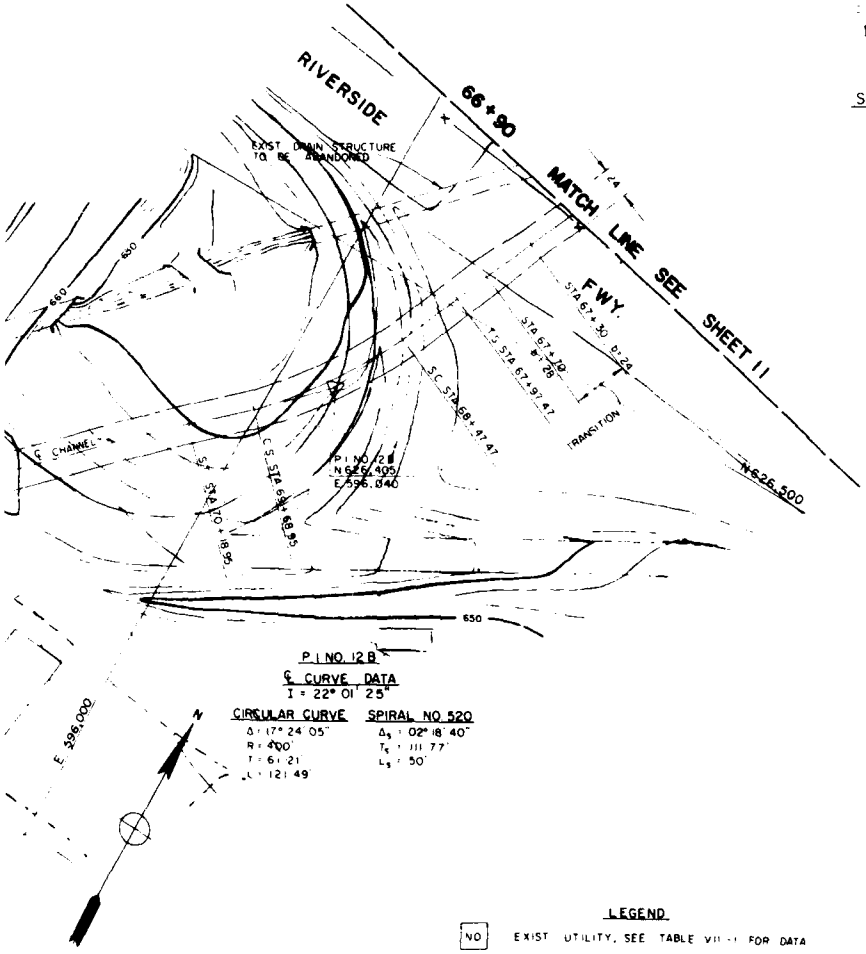
HYDRAULIC ELEMENTS								
					n = 0.014			
STA TO STA	SECTION	SLOPE	Q	D_c	D_A	V_A	D_A	V_A
78+93 67+70	BOX	.022675	7.00	12.9	8.8	30.2	7.7	35.9
67+70 67+30	TRANS	.022675	7.00	VARIES	7.4	36.2	8.7	34.9
67+30 66+90	BOX	.022675	7.00	14.0	8.7	34.9	8.7	35.3



PLAN

SCALE 50 0 50 100 FEET



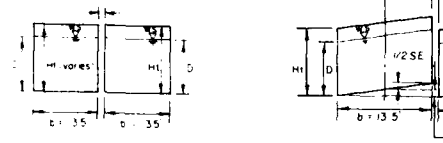


P I NO. 12 B

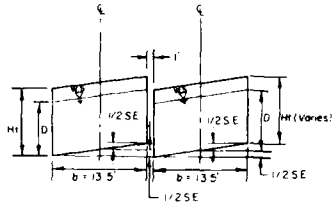
℄ CURVE DATA

I = 22° 01' 25"

CIRCULAR CURVE	SPIRAL NO. 520
Δ = 17° 24' 05"	Δ_s = 02° 18' 40"
R = 400'	T_s = 111.77'
T = 61.21'	L_s = 50'
L = 121.49'	

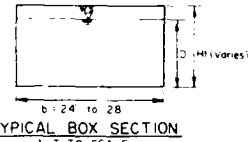


SECTION ON TANGENT

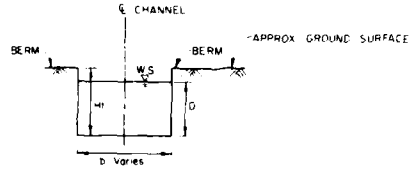


SECTION ON CURVE

TYPICAL DOUBLE BOX SECTIONS
NOT TO SCALE



TYPICAL BOX SECTION
NOT TO SCALE



TYPICAL OPEN SECTION
NOT TO SCALE

LEGEND

- NO — EXIST UTILITY, SEE TABLE VII-1 FOR DATA
- RECOMMENDED DOUBLE DRIVE GATE
- EXIST POWER POLE
- EXIST DIRT ROAD.
- (NO) EXIST SIDE DRAIN LOCATION SEE TABLE IV-2 OR IV-2a FOR DATA

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

SANTA ANA RIVER MAINSTEM, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

PLAN AND PROFILE

STA 78+93 TO STA 66+90

SUBMITTED BY:

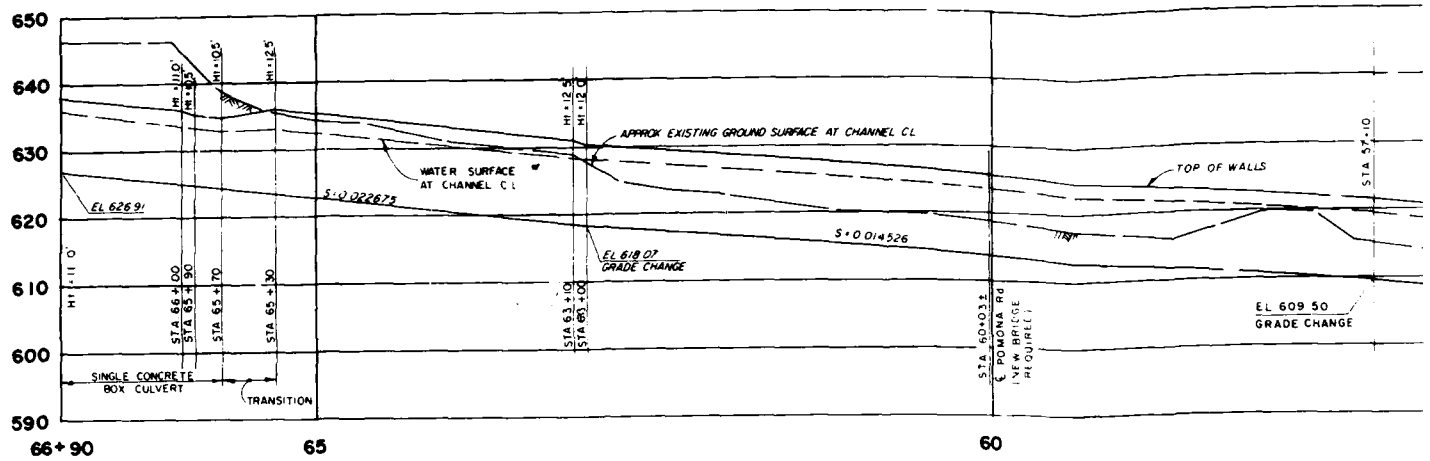
DATE APPROVED:

SPEC. NO. DACW09-___-B-___

DISTRICT FILE NO.

SHEET NO. 10 OF 14

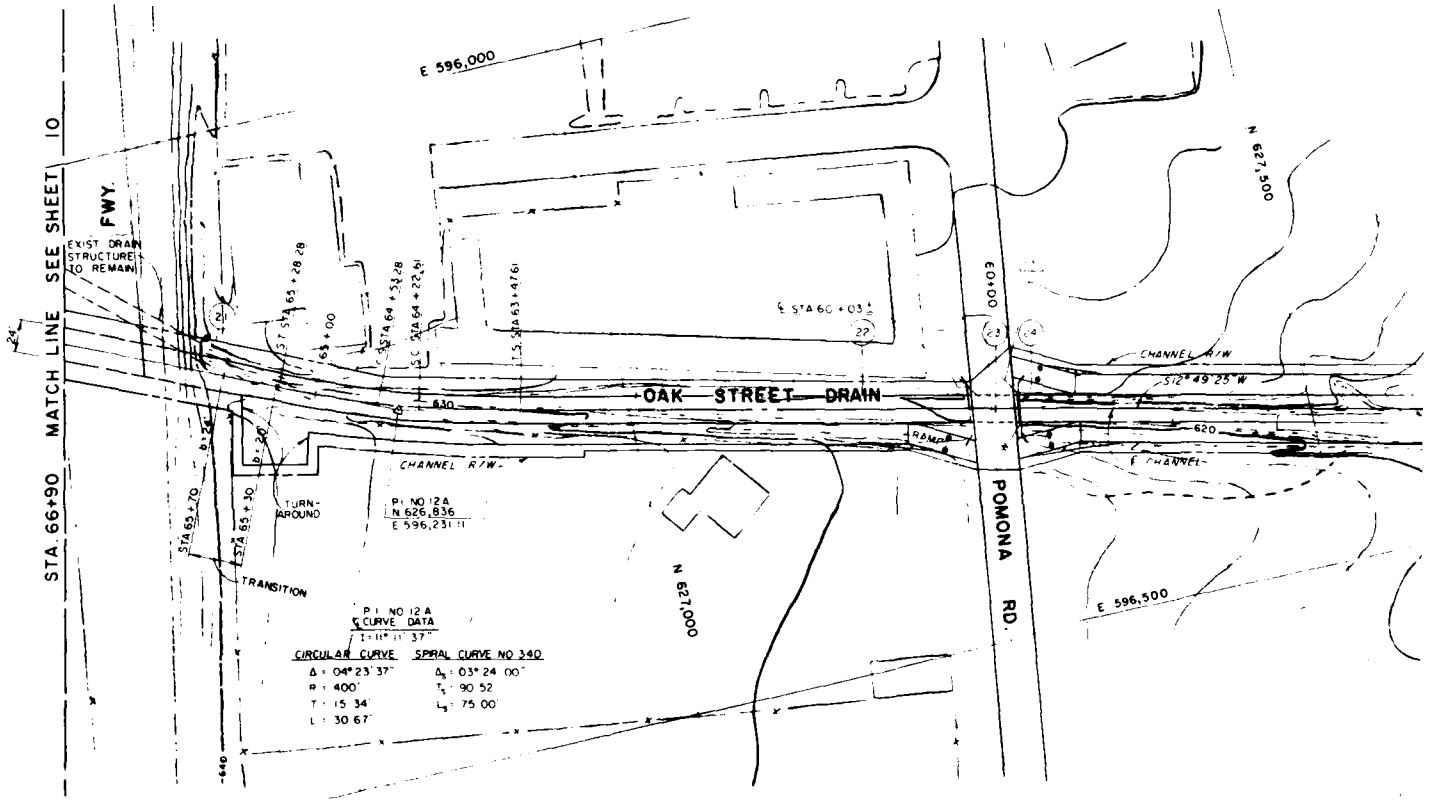
PLATE 12



PROFILE

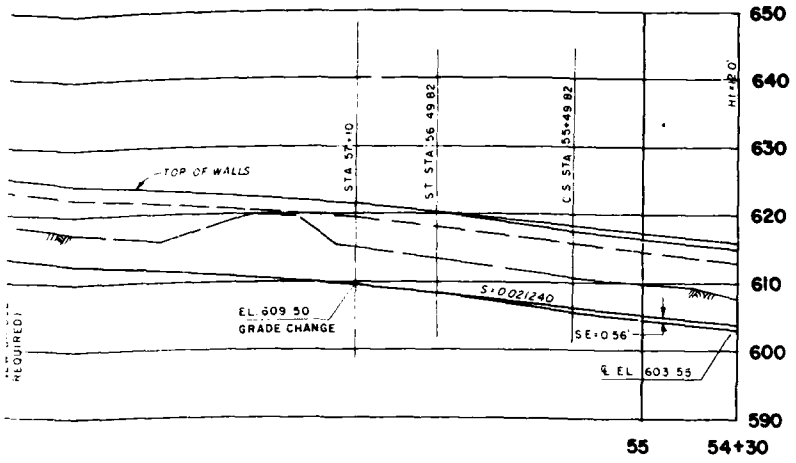
HORIZ SCALE 50 0 50 FEET

VERT SCALE 5 0 5 10 FEET



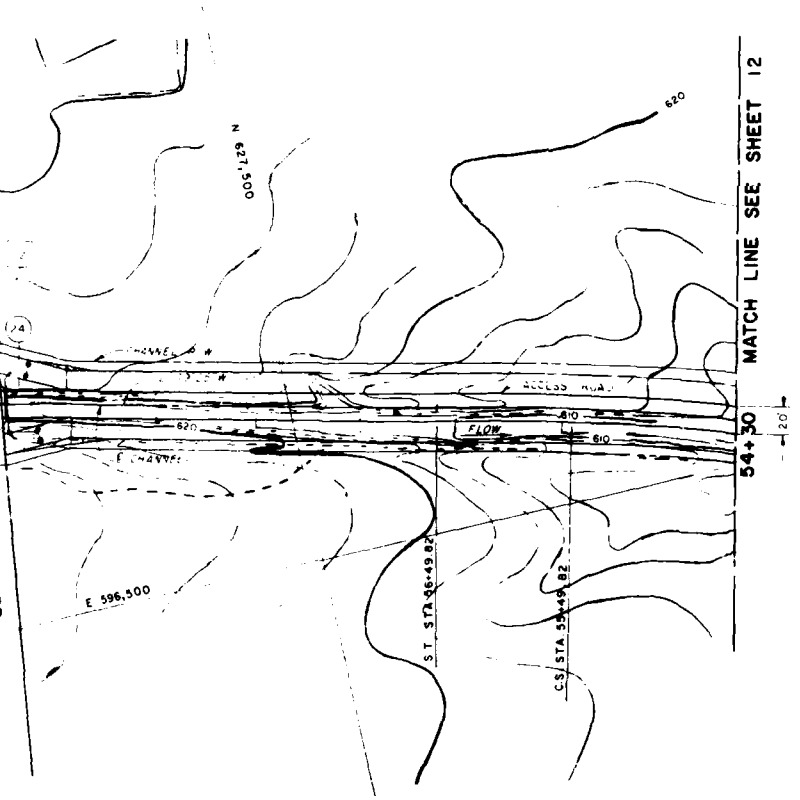
PLAN

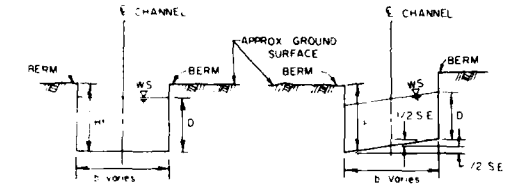
HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
66+90	65+70	Box	.022675	7100	14.0	8.7	35.3	8.4	36.8
65+70	65+30	Trans	.022675	7100	Varies	8.4	36.6	10.5	34.5
65+30	63+00	20' Rect.	.022675	7100	15.8	10.5	34.5	9.9	37.0
63+00	57+10	20' Rect.	.014526	7100	15.8	9.9	37.0	9.9	37.0
57+10	54+30	20' Rect	.021240	7100	15.8	9.9	37.0	9.5	38.7



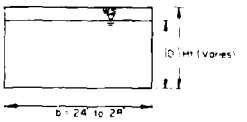
100 FEET

30 FEET





OPEN SECTION ON TANGENT OPEN SECTION ON CURVE



BOX SECTION

TYPICAL SECTIONS
NO SCALE

LEGEND

NO EXIST UTILITY, SEE TABLE VII-1 FOR DATA

NO EXIST SIDE DRAIN, SEE TABLE IV-2a FOR DATA

RECOMMENDED DOUBLE DRIVE GATE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

HALAND ENGINEERING
CIVIL ENGINEERING · SURVEYING · LAND PLANNING
1000 SUPERIOR STREET, SAN DIEGO, CALIFORNIA, 92101

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

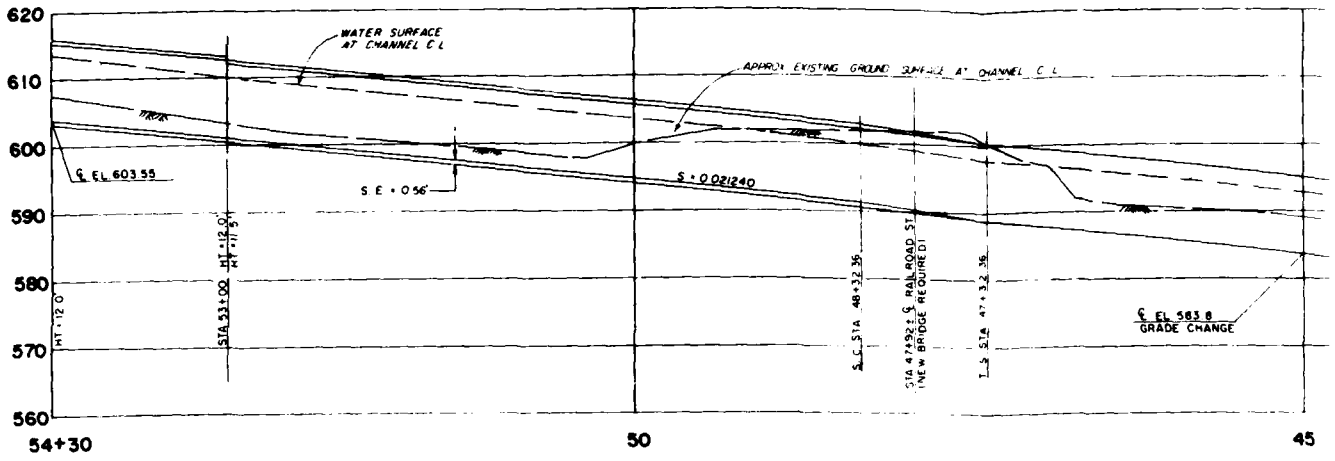
OAK STREET DRAIN
PLAN AND PROFILE
STA 66+90 TO STA 54+30

SUBMITTED BY: DATE APPROVED:
CHIEF, ENGINEERING DIVISION

SPEC. NO. DACW09-____-B-____
DISTRICT FILE NO.

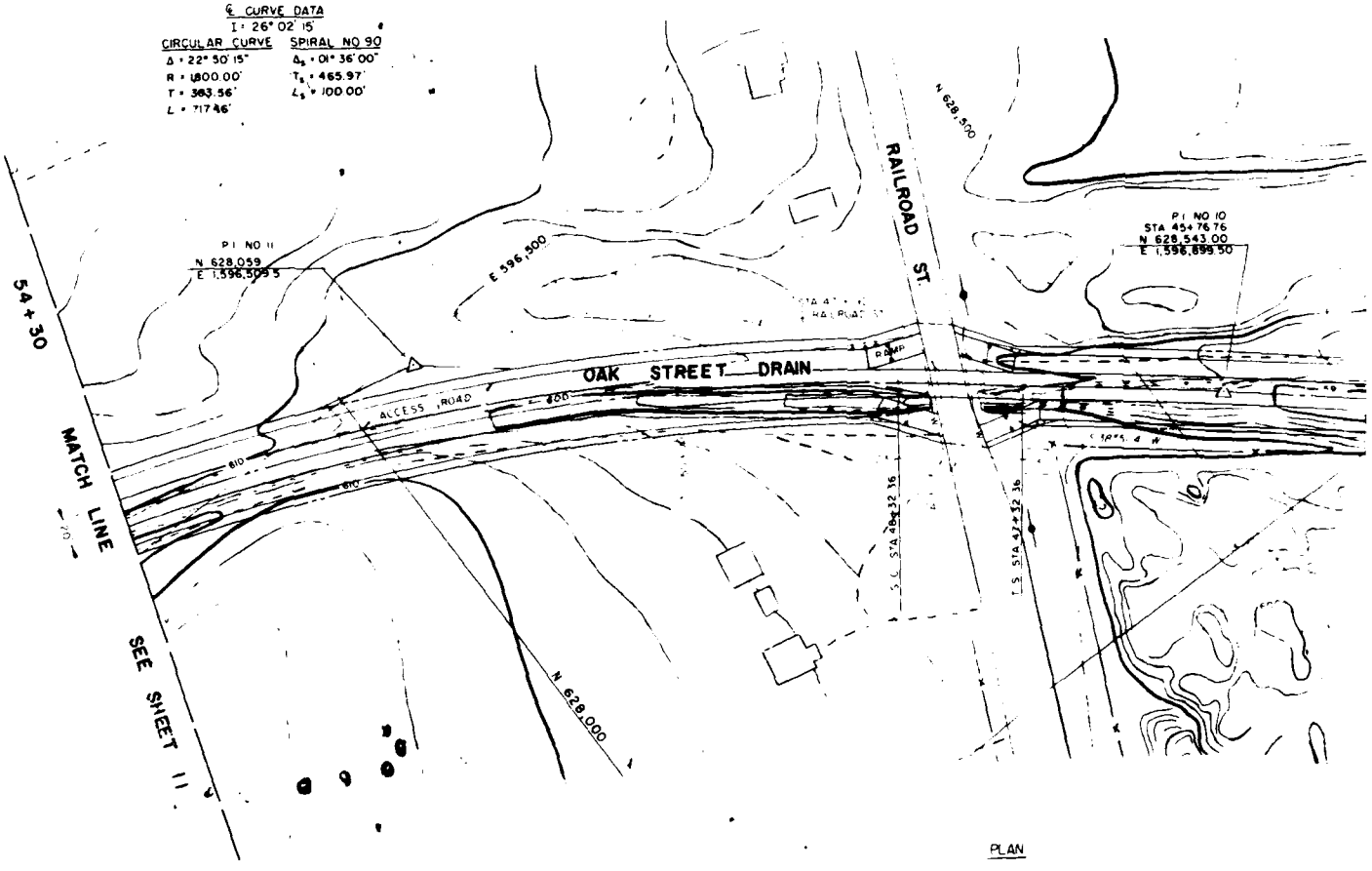
SHEET 11 OF 19

PLATE 13

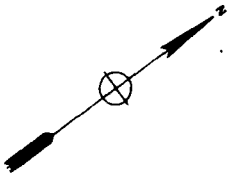


P.I. NO 11
℄ CURVE DATA
I = 26° 02' 15"

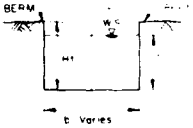
CIRCULAR CURVE	SPIRAL NO 90
Δ = 22° 50' 15"	Δ_s = 01° 36' 00"
R = 1800.00'	T_s = 465.97'
T = 363.56'	L_s = 100.00'
L = 717.46'	



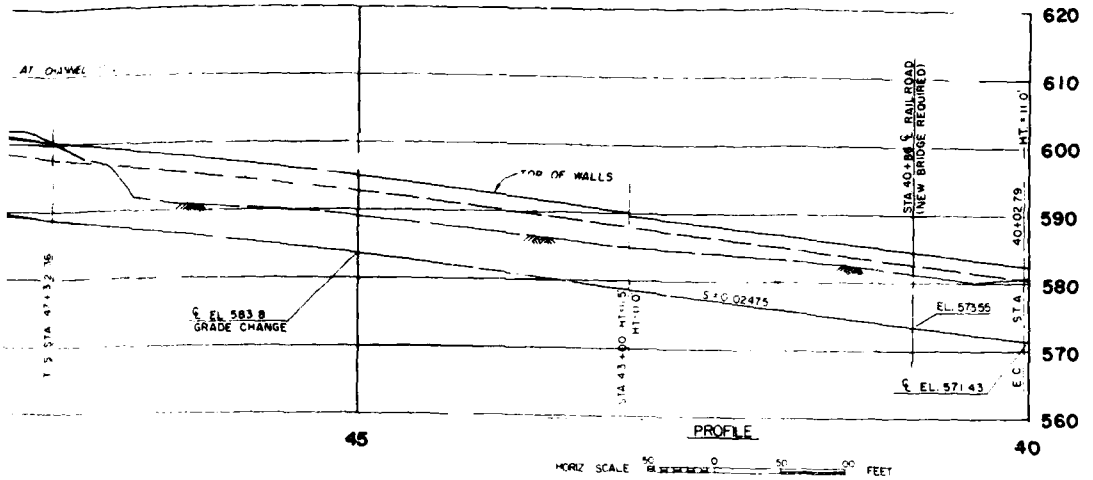
PLAN

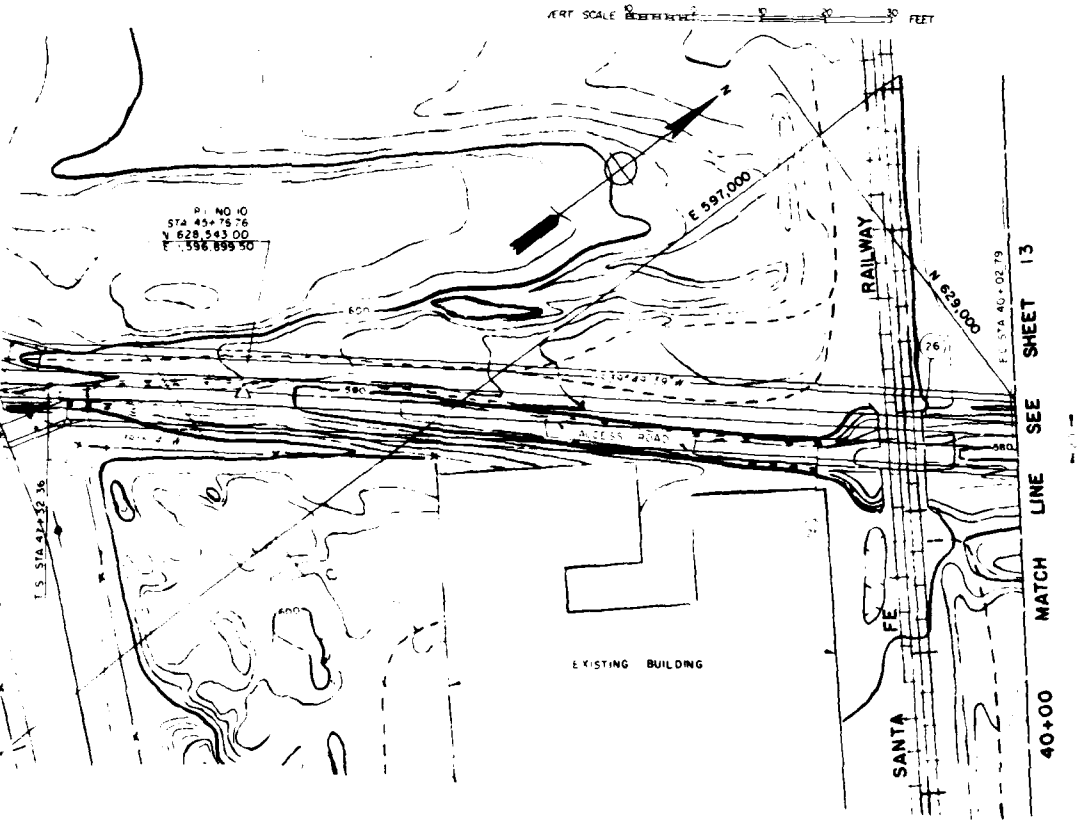


HYDRAULIC ELEMENTS									
STA. TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						D_A	V_A	D_A	V_A
54+30	45+00	20' Rect.	.021240	7100	15.8	9.5	38.7	9.1	41.3
45+00	40+00	20' Rect.	.024745	7100	15.8	9.1	41.3	8.8	43.1



SECTION ON TANGEN

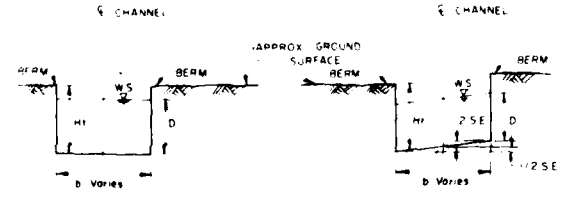




PLAN

LEGEND

- (NC) EXIST. UTILITY, SEE TABLE VII FOR DATA
- (N2) EXIST. SIDE DRAIN LOCATION, SEE TABLE V-2 OR IV-26 FOR DATA
- RECOMMENDED DOUBLE DRIVE GATE
- EXISTING POWER POLE
- EXISTING DIRT ROAD



SECTION ON TANGENT

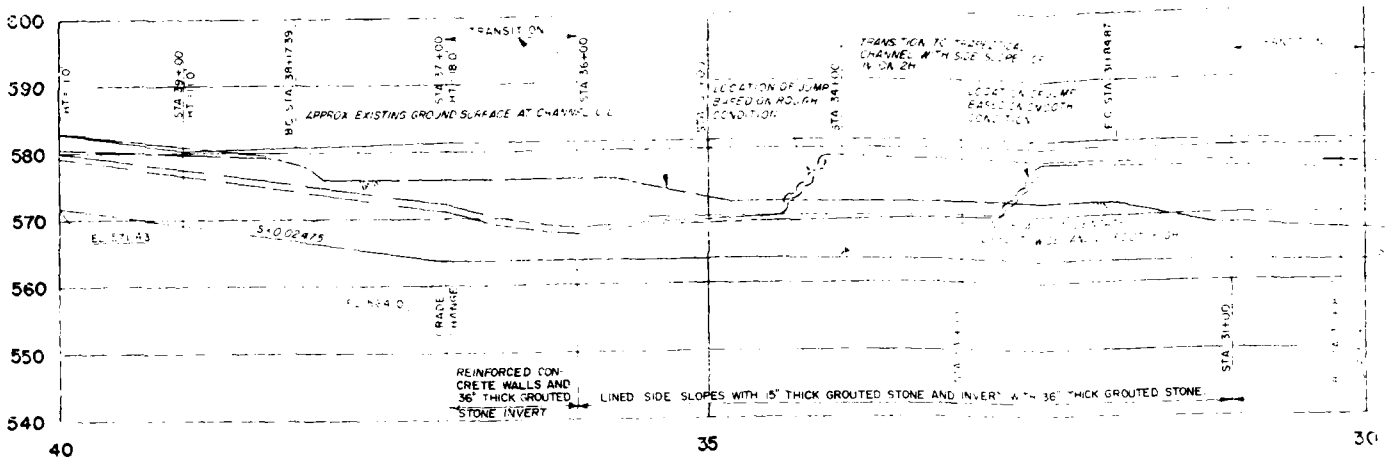
SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RAILARD ENGINEERING CIVIL ENGINEERING SURVEYING LAND PLANNING 1000 SOUTHERN STREET, P.O. RIVER, CALIFORNIA, 92111	U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS
DESIGNED BY	SANTA ANA RIVER MAINSTEM, CALIFORNIA
	PHASE II GENERAL DESIGN MEMORANDUM
DRAWN BY	OAK STREET DRAIN
CHECKED BY	PLAN AND PROFILE
	STA 54+30 TO STA 40+00
SUBMITTED BY: DATE APPROVED:	SPEC. NO. DACW09-____-B-____ SHEET 2 OF 4
CHIEF, ENGINEERING DIVISION	DISTRICT FILE NO

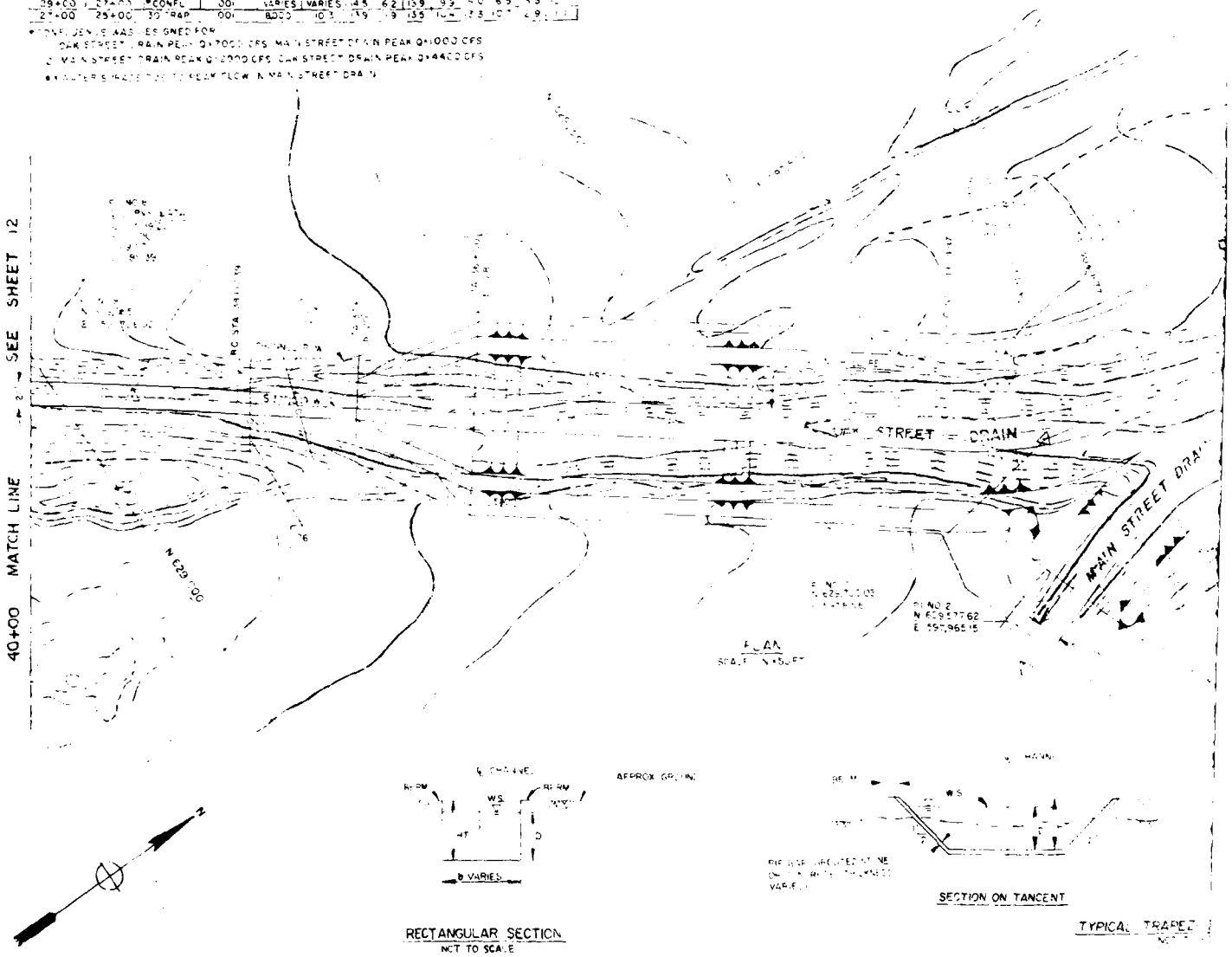
PLATE 14



HYDRAULIC ELEMENTS

STA TO STA	SECTION	SLOPE	Q	Dc	n=0.014 DA	n=0.014 VA	CA	CA	VA
40+00 37+00	20' RECT	.02475	7100	15.9	8.8	43.0	8.7	43.0	8.6
37+00 36+00	TRANS	.00	7100	VARIES	8.7	43.6	4.9	44.2	8.
36+00 34+45	28' TRAP	.001	7100	3.9	4.9	44.2	6.1	30.5	4.8
HYDRAULIC JUMP AT STA 34+45									
34+45 31+00	28' TRAP	.001	7100*	9.9	15.1	8.1	4.9	8.	
31+00 30+00	TRANS	.001	7100*	VARIES	4.9	32.1	4.5	62.	
30+00 29+00	20' TRAP	.001	7100*	8.61	4.5	62.1	4.5	62.	
29+00 27+00	8' CONFL	.001	VARIES	VARIES	4.5	62.1	3.9	99.	
27+00 25+00	30' TRAP	.001	8000	10.3	3.9	99.1	3.5	10	2.9

* CONFLUENCE ASSUMED FOR
OAK STREET DRAIN PEAK Q=7000 CFS, MAIN STREET DRAIN PEAK Q=1000 CFS
MAIN STREET DRAIN PEAK Q=2000 CFS, OAK STREET DRAIN PEAK Q=4400 CFS
** WATER SURFACE FOR TO STREAM FLOW IN MAIN STREET DRAIN

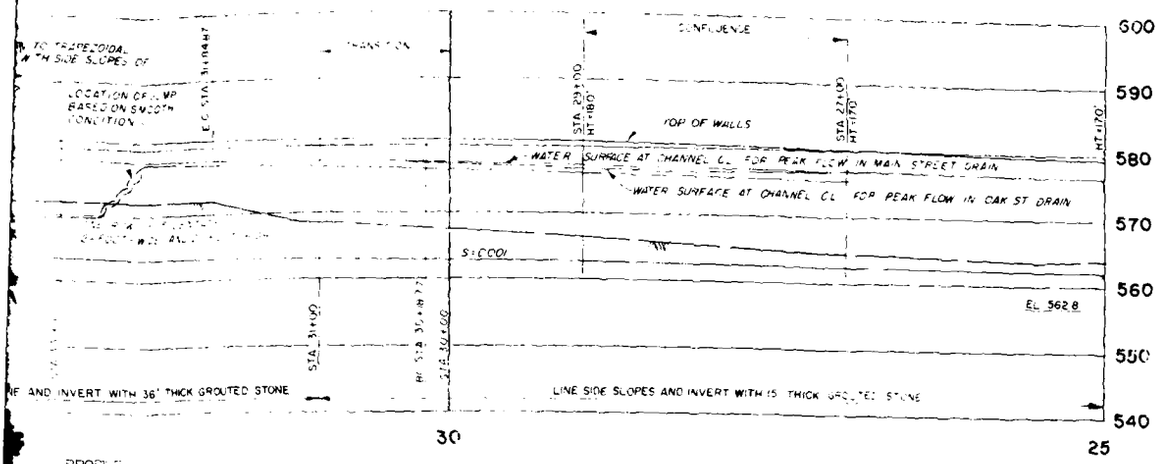


RECTANGULAR SECTION
NOT TO SCALE

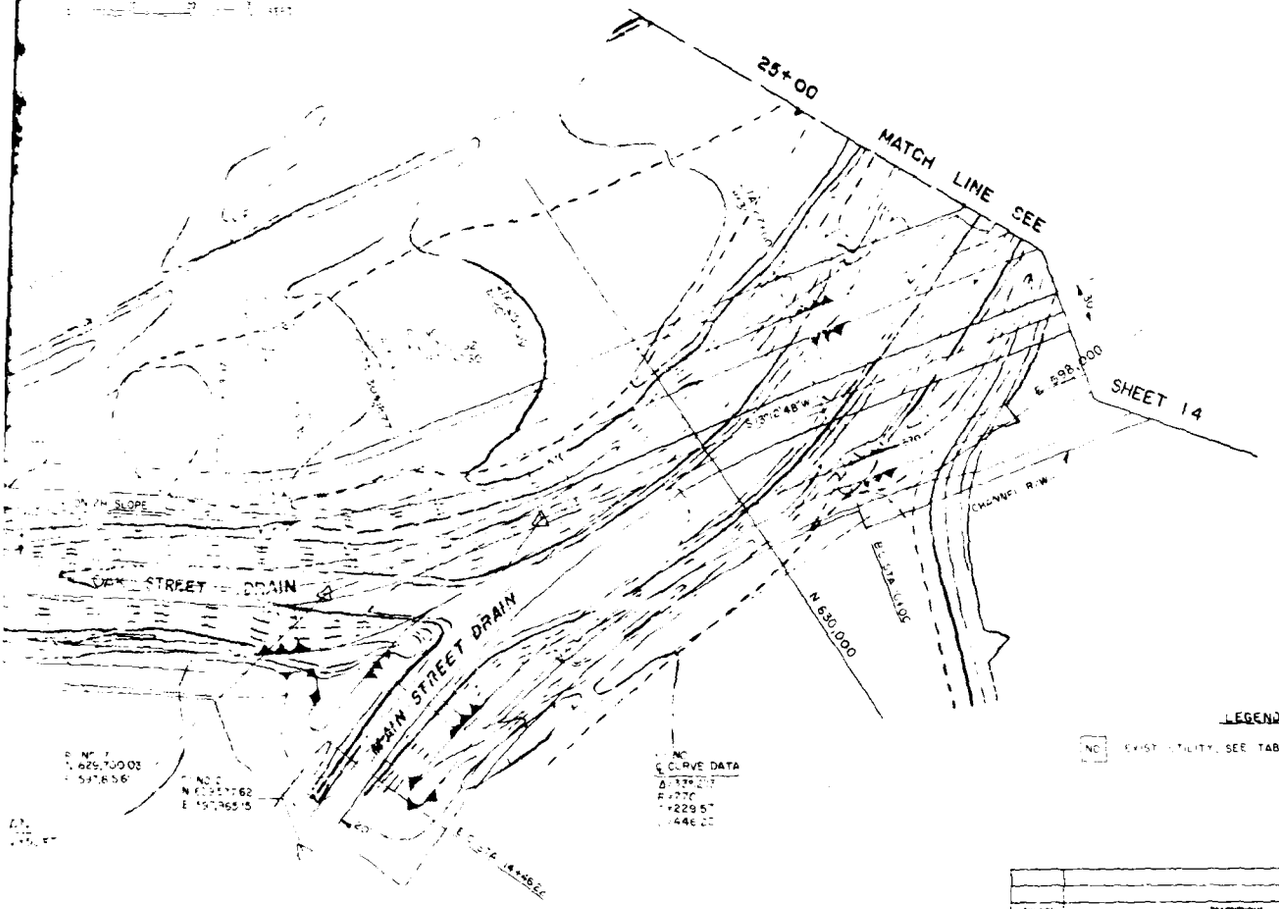
SECTION ON TANGENT

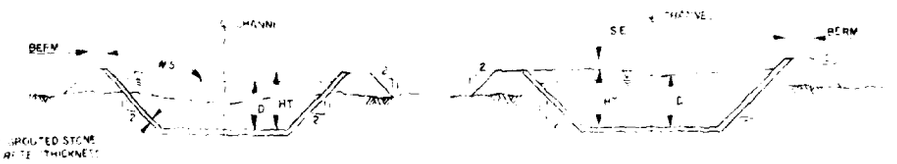
TYPICAL TRAPEZ

VALUE ENGINEERING PAYS



PROFILE





SECTION ON TANGENT

SECTION ON CURVE

TYPICAL TRAPEZOIDAL SECTIONS
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY

DRAWN BY

CHECKED BY

SANTA ANA RIVER, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
PLAN AND PROFILE
STA 40+00 TO STA 25+00

SUBMITTED BY

DATE APPROVED

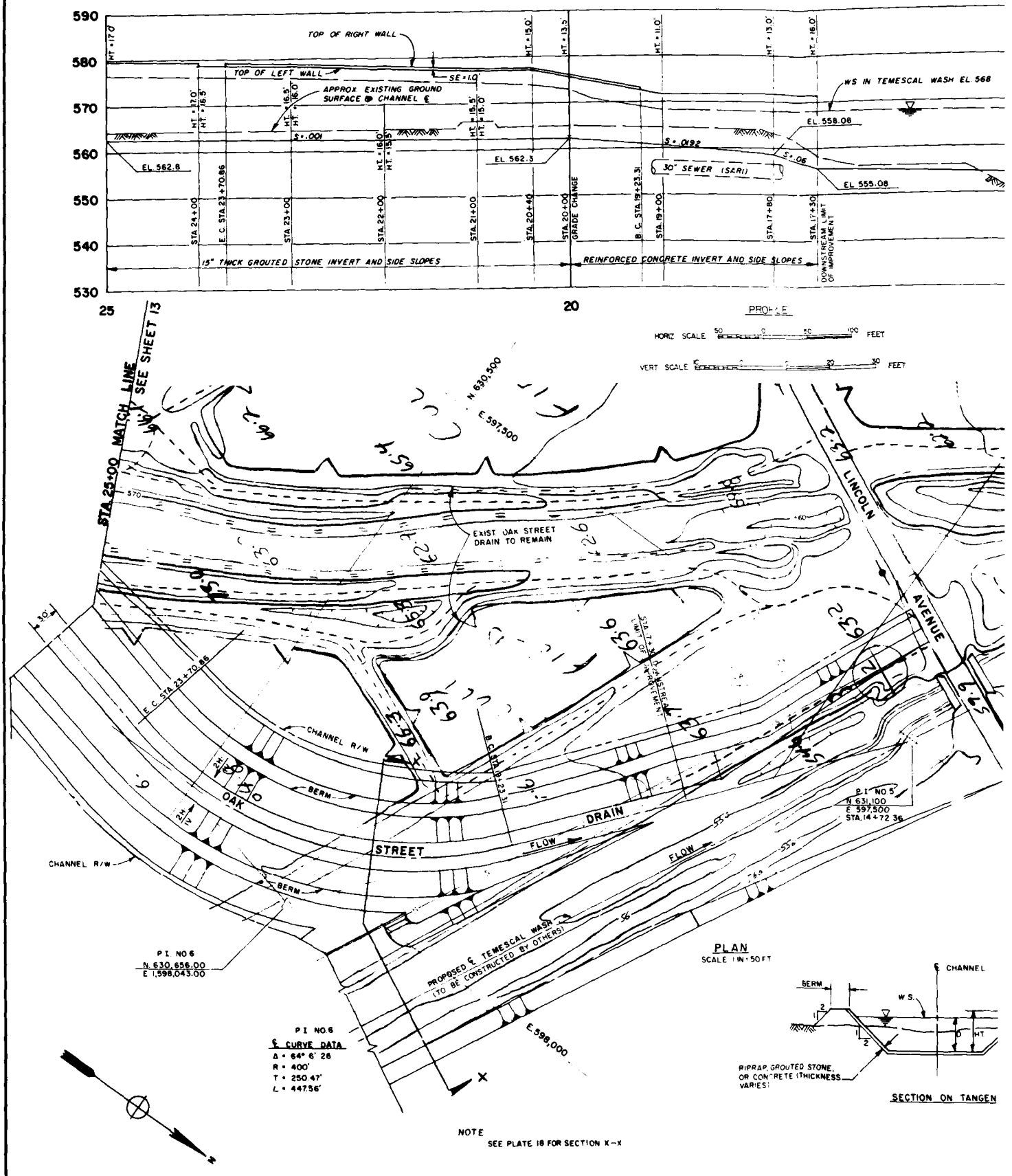
SPEC NO DACW

DISTRICT FILE NO

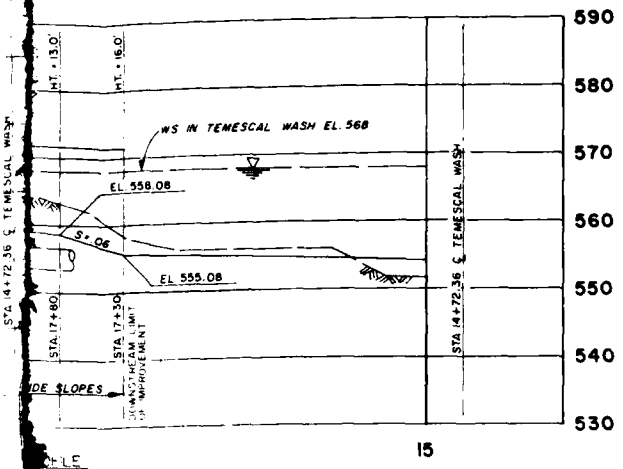
SHEET 3 OF 4

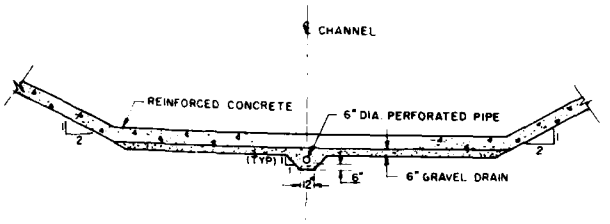
SAFETY PAYS

PLATE 15

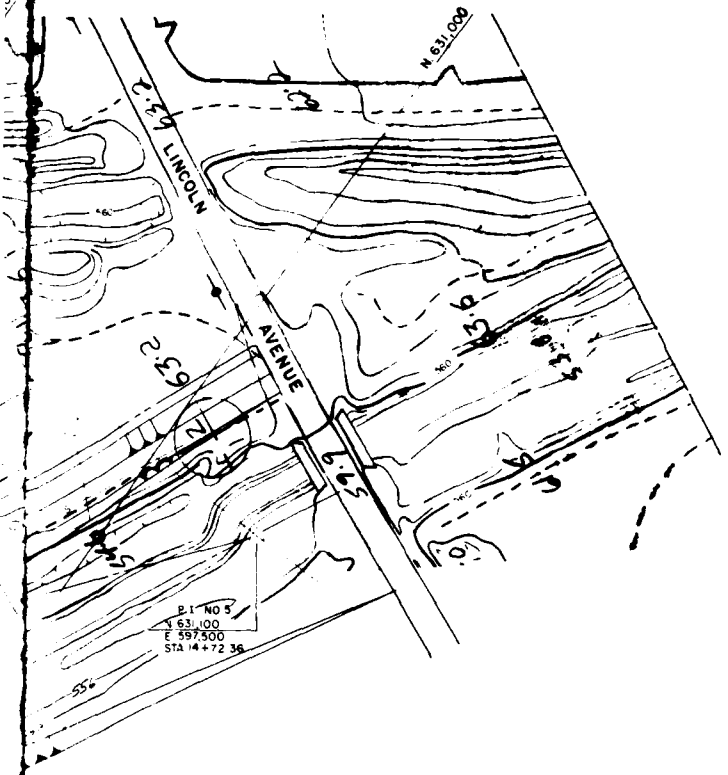


NOTE
SEE PLATE 18 FOR SECTION X–X





SUBDRAIN DETAIL
STA 20+00 TO STA 17+30
SCALE 1 IN = 5 FT.



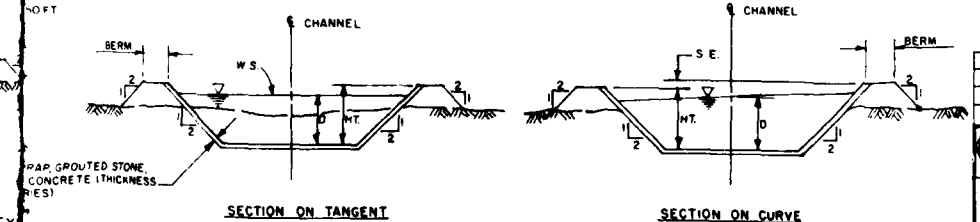
LEGEND

(NO.) EXIST. UTILITY, SEE TABLE VIII-1 FOR DATA

(NO.) EXIST. SIDE DRAIN LOCATION, SEE TABLE IV-2a FOR DATA

HYDRAULIC ELEMENTS

STA. TO STA.		SECTION	SLOPE	Q	Dc	n = .030			
						DA	VA	DA	VA
25+00	20+00	30 TRAP.	.001	8,000	10.3	13.5	10.4	10.3	15.3
					CONCRETE n = .014				
20+00	17+80	30 TRAP	.0192	8,000	10.3	10.3	15.3	7.1	25.5
17+80	17+30	30 TRAP	.060	8,000	10.3	7.1	25.5	6.5	29.4



SECTION ON TANGENT

SECTION ON CURVE

TYPICAL SECTION
NOT TO SCALE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

NASLAND ENGINEERING
CIVIL ENGINEERING SURVEYING LAND PLANNING
9320 BEVERLY STREET, SUN VALLEY, CALIFORNIA, 91352

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

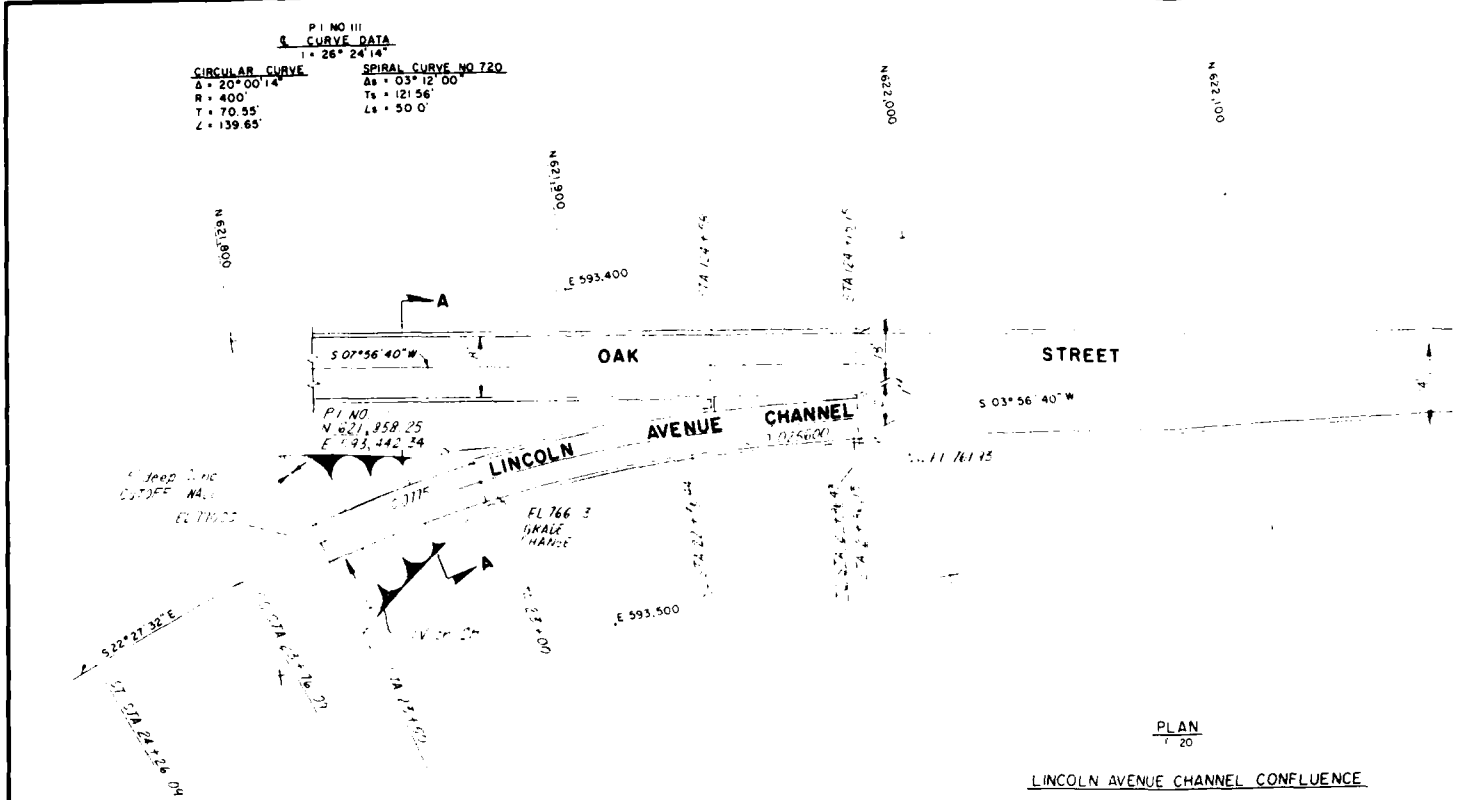
SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN
PLAN AND PROFILE
STA 25+00 TO STA 14+72.36

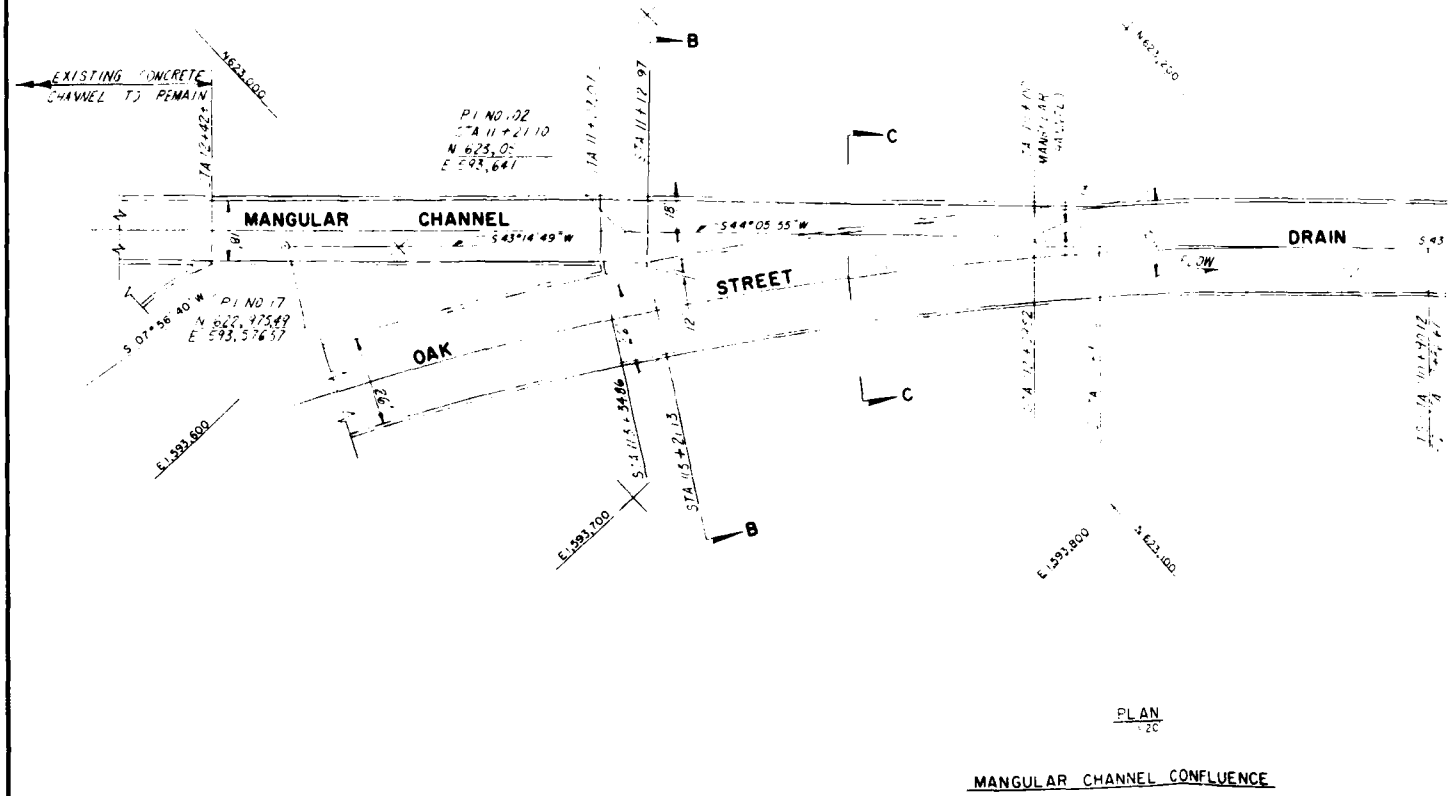
SUBMITTED BY: DATE APPROVED:

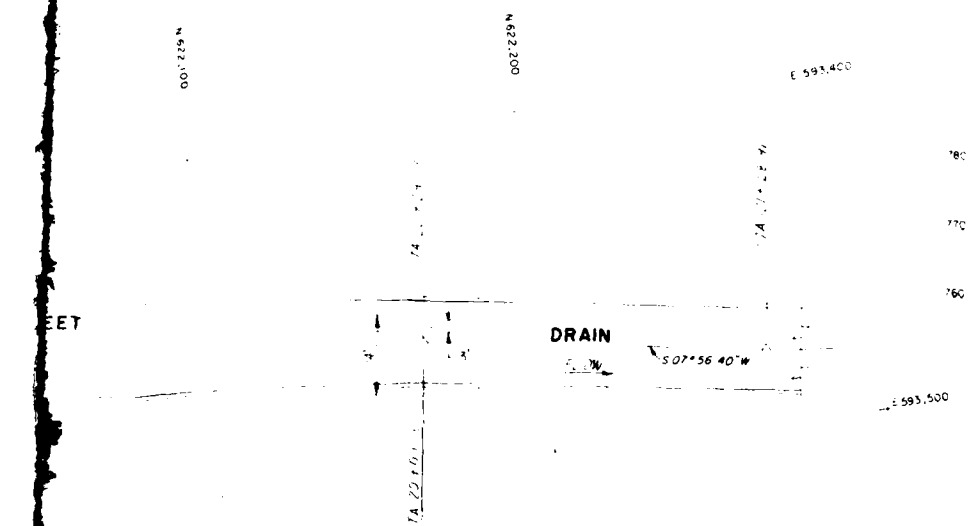
SPEC. NO. DACW09-____-8-____
DISTRICT FILE NO

SHEET 14 OF 14

PLATE 16

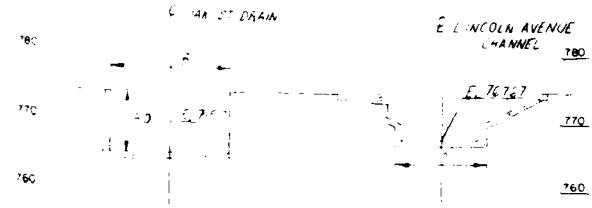

P I NO 111
℄ CURVE DATA
I = 26° 24' 14"
CIRCULAR CURVE
Δ = 20° 00' 14"
R = 400'
T = 70.55'
L = 139.65'
SPIRAL CURVE NO 720
Δs = 03° 12' 00"
Ts = 121.56'
Ls = 50.0'
N 622,000
N 621,900
N 621,800
N 621,229.100
E 593,400
E 593,500
A
A
S 07°56'40"W
OAK
STREET
S 03°56'40"W
P I NO
N 621,958.25
E 593,342.34
LINCOLN
AVENUE
CHANNEL
FL 766.3
S 22°27'32"E
PLAN
1" = 20'
LINCOLN AVENUE CHANNEL CONFLUENCE


EXISTING CONCRETE
CHANNEL TO REMAIN
N 623,000
B
C
P I NO 102
N 625,0
E 593,641
MANGULAR
CHANNEL
S 43°14'49"W
S 44°05'55"W
DRAIN
STREET
OAK
P I NO 17
N 622,475.49
E 593,576.57
S 07°56'40"W
E 593,600
E 593,700
E 593,800
N 623,100
B
C
PLAN
1" = 20'
MANGULAR CHANNEL CONFLUENCE

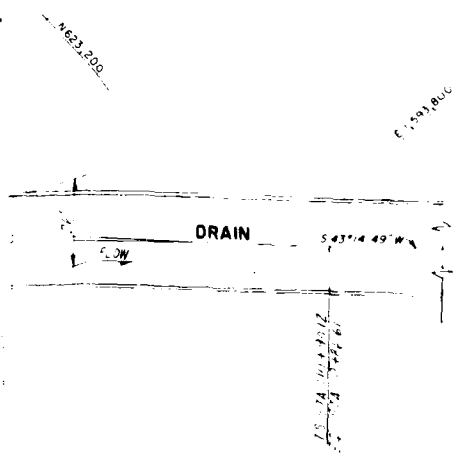


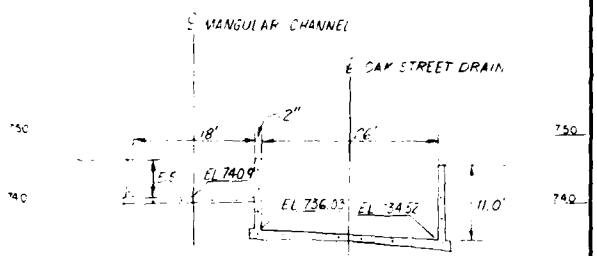
PLAN
1" = 20'

N AVENUE CHANNEL CONFLUENCE



SECTION A-A
1" = 10'



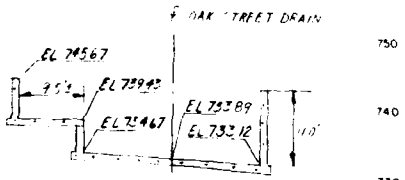


SECTION B-B
1" = 10'

N 623,100

PLAN
1" = 20'

CHANNEL CONFLUENCE



SECTION C-C
1" = 10'

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

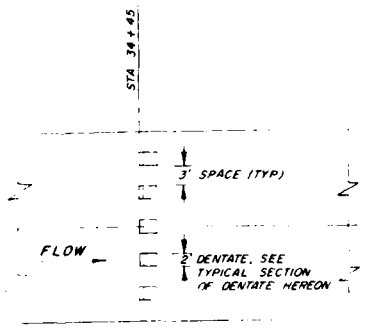
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

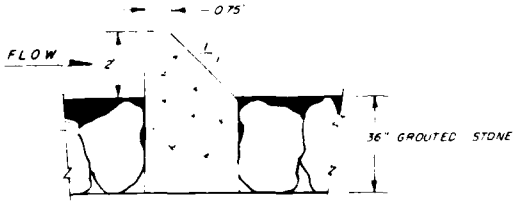
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN
LINCOLN AVENUE AND MANGULAR
CHANNEL CONFLUENCES

SUBMITTED BY: CHIEF, BRANCH
DATE APPROVED:
SPEC. NO. DACW09-___-B-___
DISTRICT FILE NO.
SHEET ___ OF ___

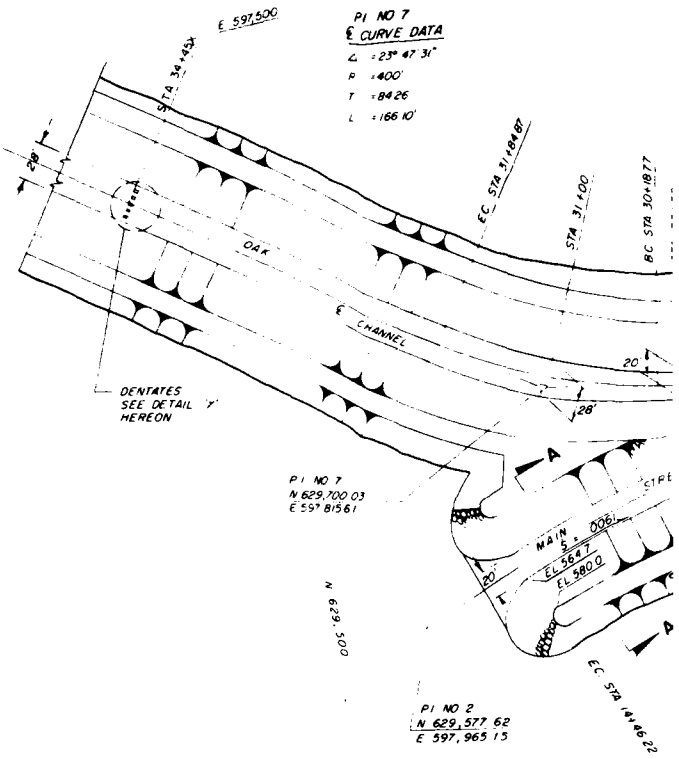
PLATE 17



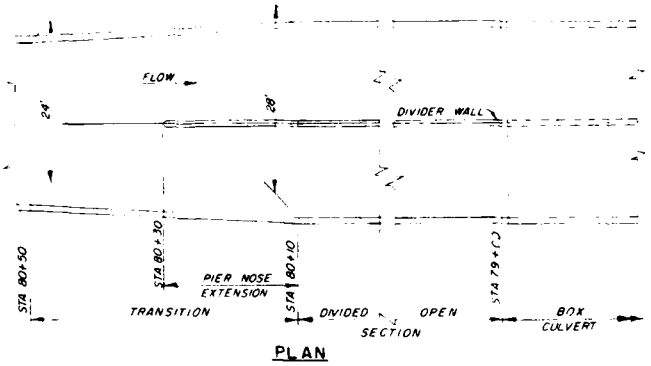
DETAIL 'X'



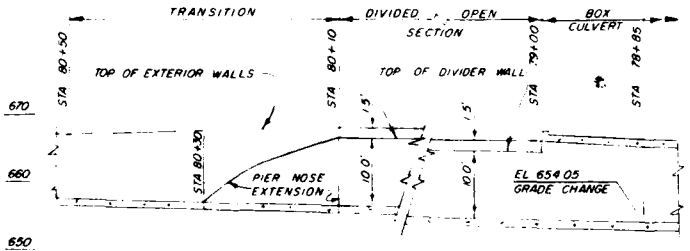
TYPICAL SECTION OF DENTATE



MAIN STRE



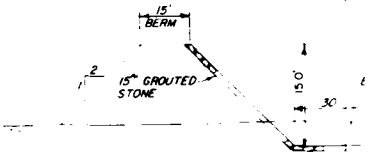
PLAN

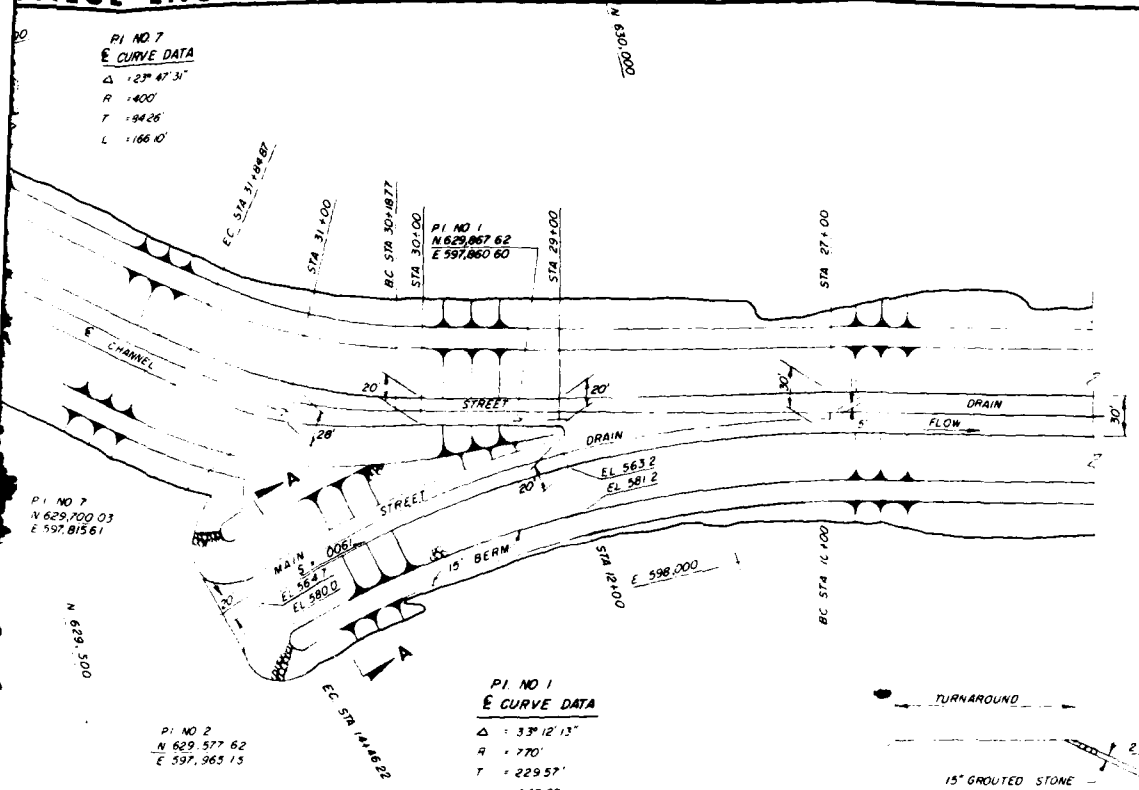


PROFILE

DETAIL OF OPEN TO COVERED CHANNEL

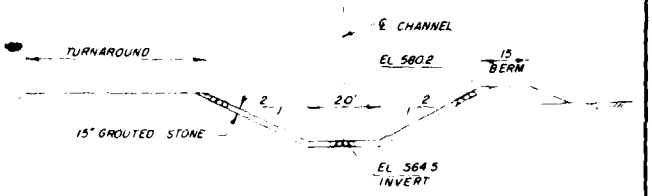
1" = 10'



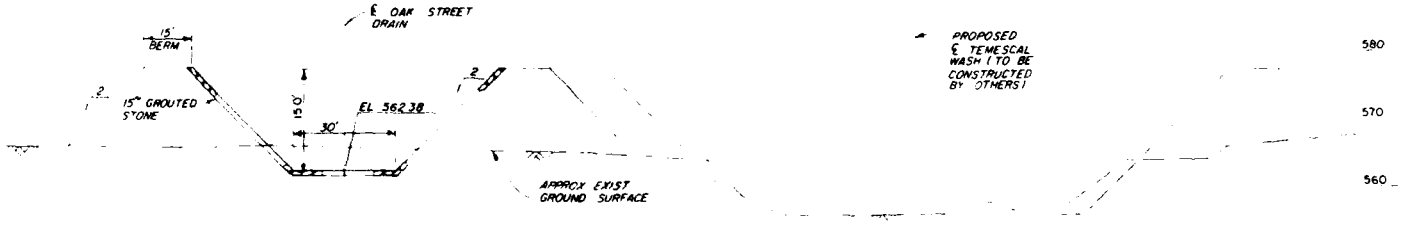


PLAN
1 IN = 50 FT

MAIN STREET DRAIN CONFLUENCE



SECTION A-A
1 IN = 20 FT



NOTE: FOR LOCATION OF SECTION X-X SEE PLATE 16

SECTION X-X
HORIZ SCALE 1" = 20'
VERT SCALE 1" = 10'

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

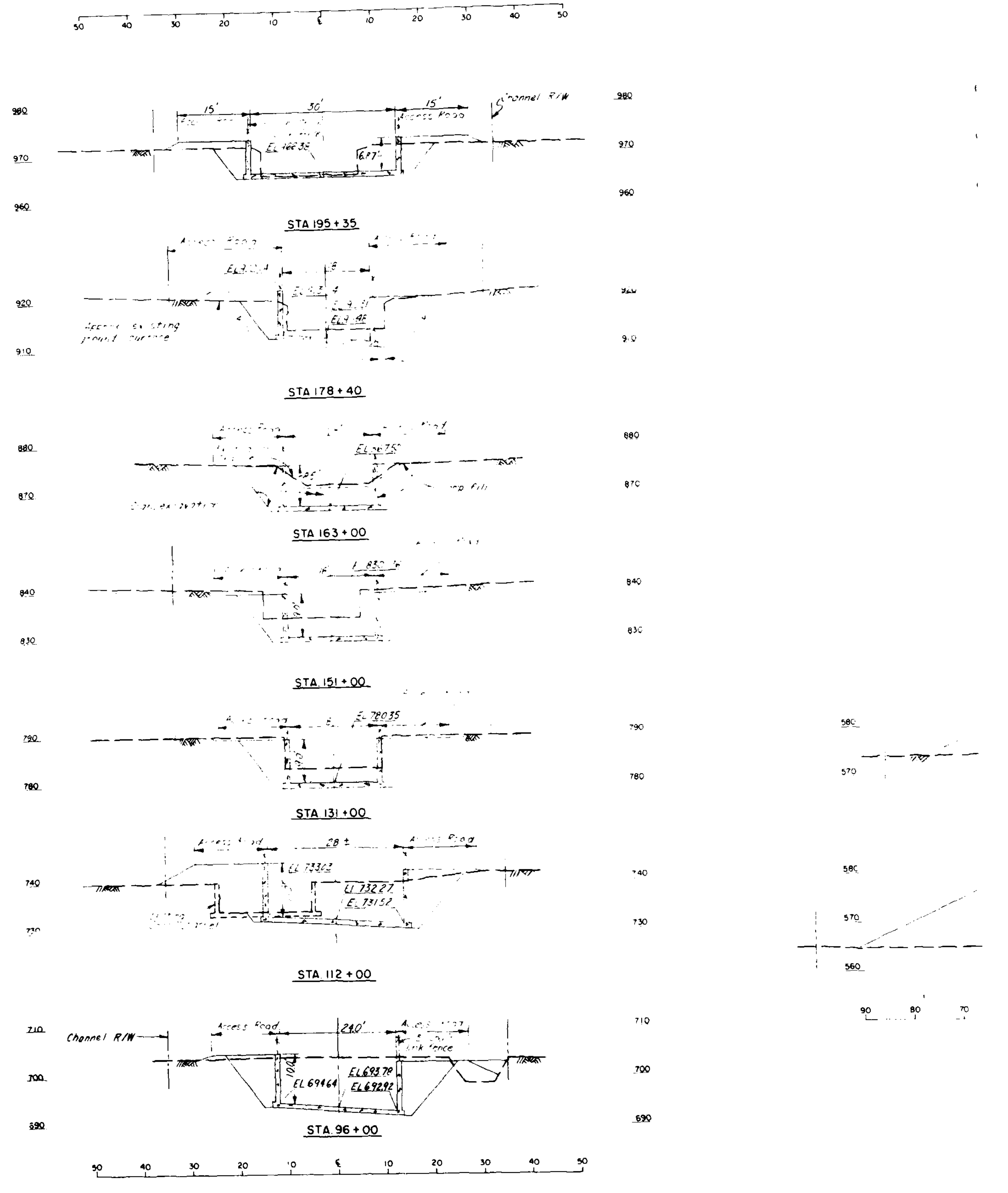
MAIN STREET DRAIN CONFLUENCE, DENTATES, AND DETAIL OF OPEN TO COVERED CHANNEL

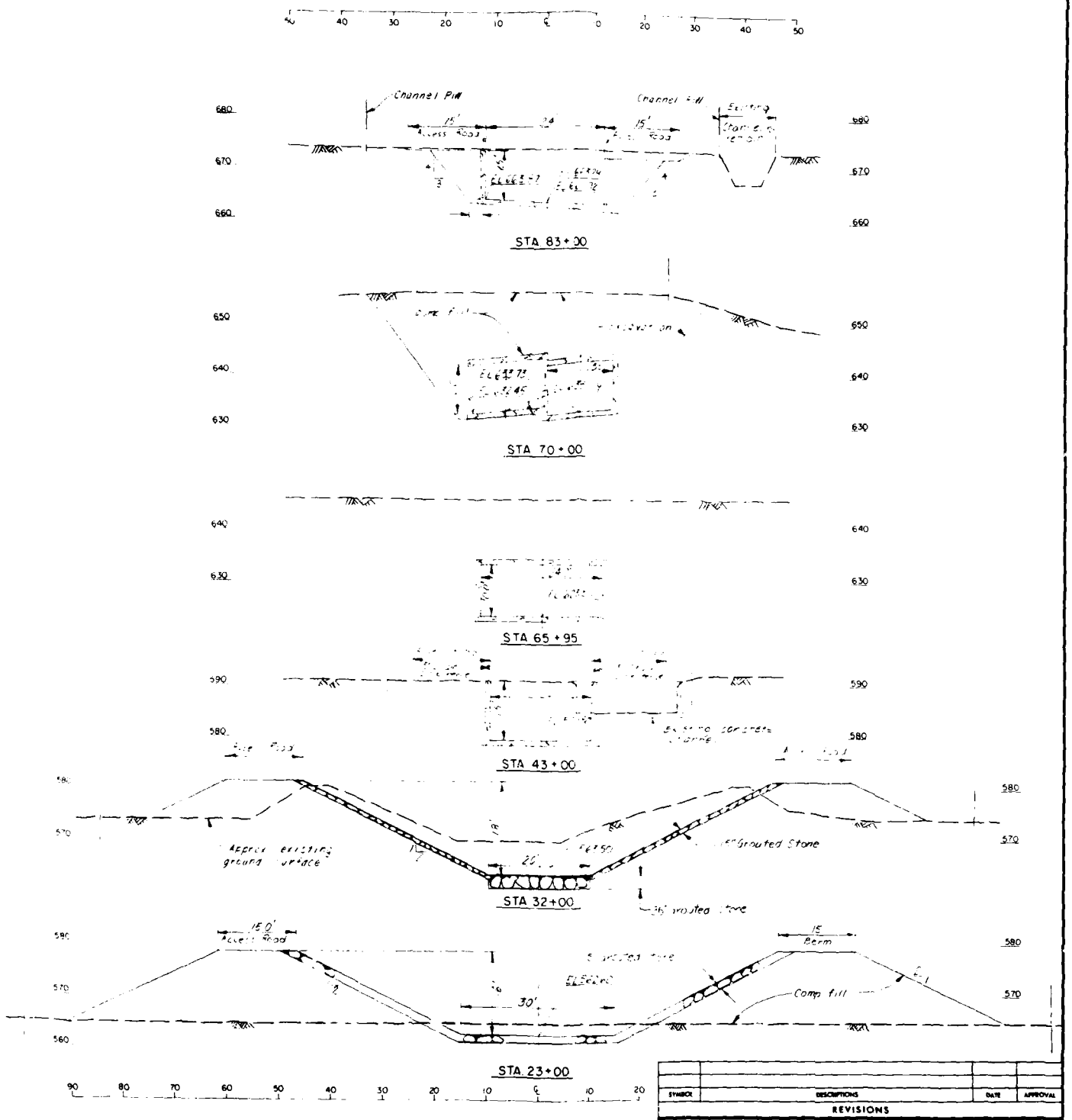
SUBMITTED BY: DATE APPROVED:

SPEC NO. DACW09-____-B-____

DISTRICT FILE NO

SHEET 1 OF 1


STA 195 + 35
15'
30'
15'
Channel R/W
Access Road
STA 178 + 40
STA 163 + 00
STA 151 + 00
STA 131 + 00
28 ±
Access Road
EL 733.02
EL 732.27
EL 731.52
STA 112 + 00
Channel R/W
Access Road
24.0'
EL 694.64
EL 693.79
EL 692.92
STA 96 + 00



SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SANTA ANA RIVER, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
CROSS-SECTIONS

SUBMITTED BY: CHIEF, BRANCH

DATE APPROVED:

SPEC. NO. DACW09-___-B-___

DISTRICT FILE NO.

SHEET 1 OF 1

PLATE 19

A DRAFT CONTRACT—RAILROAD

Contract No.

CONTRACT FOR MODIFICATION, REARRANGEMENT OR ALTERATION OF FACILITIES (COST REIMBURSABLE)

OWNER AND ADDRESS:	THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY 80 East Jackson Boulevard Chicago, Illinois 60604
CONTRACT FOR:	Modification of Existing Railroad Bridge
AMOUNT:	$207,000
LOCATION:	Oak Street Drain, Corona, California Riverside County Santa Ana River Drainage Area, California
PAYMENT TO BE MADE BY:	Finance and Accounting Officer Department of the Army Los Angeles District, Corps of Engineers 300 North Los Angeles Street P.O. Box 2711 Los Angeles, California 90053

The payment to be made by this instrument is authorized for the purpose set forth herein, and is chargeable to the appropriation below enumerated, the available balance of which is sufficient to cover the amount thereof:

96X3122 Construction General, C. of E., Civil AF4211055*00000

This Contract is authorized by the Water Resources Development Act of 1986, 99th Congress 2nd Session, Report 99-1013, Title IV, Flood Control, Section 401.

Contract No.

CONTRACT FOR MODIFICATION, REARRANGEMENT

OR ALTERATION OF FACILITIES

(COST REIMBURSABLE)

This contract, entered into this _____ day of _____ 19___, between the UNITED STATES OF AMERICA (hereinafter called the "Government"), represented by the Contracting Officer executing this contract, and THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY, a corporation organized and existing under the laws of the State of Delaware, with its principal office and place of business in the City of Chicago, State of Illinois (hereinafter called Santa Fe);

WITNESSETH THAT:

WHEREAS, the Government has, under authority of the Water Resources Development Act of 1986, Report 99-1013, Title IV Flood Control, Section 401, herein after referred to as the Water Resources Development Act of 1986, undertaken the development of a flood control project known as the Santa Ana River Mainstem (including Santiago Creek) (hereinafter called the "Project" as shown on Exhibit A), including as a part thereof, the construction of a flood control channel across Santa Fe's right-of-way on the Oak Street Drain, (hereinafter called the "Channel Project" at the location shown on Exhibit "A"); and

WHEREAS, Santa Fe is the holder of certain fee title and/or easement rights appurtenant thereto on which the Santa Fe has constructed and is operating and maintaining certain facilities, consisting of a double track railroad bridge No. 24.94, Third District, Corona, California and trackage crossing the Oak Street Drain, which will be affected by the development and use of the Project by the Government; and

WHEREAS, it is necessary in the construction, completion and enjoyment by the Government of said Project that the aforementioned title, rights and privileges of Santa Fe be modified, and that said facilities of Santa Fe be modified; (hereinafter called "Bridge Project" as shown on Exhibit "B"); and

WHEREAS, Santa Fe is willing to modify its rights and privileges in and to said lands and/or rights-of-way, and to provide engineering, construction and inspection of railroad facilities located thereon, in consideration of the payment by the Government of all reasonable and legitimate costs for the engineering, construction, and inspection of said facilities to be modified by the Government at such location, and in such a manner as to facilitate the construction, development, and use of the said Channel Project; and Santa Fe agrees that said consideration constitutes full, just and complete compensation for the alteration and modification of its existing facilities; and

NOW THEREFORE, in consideration of the faithful performance of each party of the mutual covenants and agreements hereinafter set forth, it is mutually agreed as follows:

ARTICLE 1. OBLIGATIONS OF THE SANTA FE

a. Santa Fe shall furnish all services, labor, materials, tools and equipment necessary to perform engineering, construction and inspection in connection with the Bridge Project at the location shown on Exhibit "A", preliminary plans shown on Exhibit "B", and the estimated cost, designated Exhibit "C". Any item of work incidental to those items listed in Exhibit "C", but not mentioned therein may be included as part of this agreement as an item of work upon written approval of the Government.

b. Santa Fe shall furnish engineering, construction and inspection services in connection with the modification of its facilities so as to avoid interference with construction and operation of the Government's proposed Channel Project. Said engineering, construction and inspection services will be performed in accordance with the latest American Railway Engineering Association Manuals and the current state of art for railway engineering and in accordance with the Government's drawing designated Exhibit "B". The Bridge Project plans and specifications provided by Santa Fe, approved by the Government, will be on file at the Office of the District Engineer, U.S. Army Engineer District, Los Angeles, Corps of Engineers, 300 North Los Angeles Street, Los Angeles, California, which by this reference, said drawings and specifications are made a part hereof. Said construction including track work for the existing tracks and shoofly will be accomplished with Santa Fe's own employees working under Railroad Labor Agreements and on a force-account basis. When practical all work will be performed at regular hourly rates, exclusive of premium overtime except as requested at time of need and based on

approval of the Contracting Officer. Such work shall include the following, together with such other pertinent items as may be delineated on the attached Exhibits "A" and "B".

(1) Santa Fe shall review the structural data prepared by the Government in design of that portion of the channel structure beneath its track facilities and the design shall be subject to the approval of Santa Fe. Santa Fe agrees to govern its rail traffic (reduce train speed) as necessary to conform to the construction conditions reflected by the Project plans, specifications, and the term of this contract.

Under certain types of rail traffic to be agreed upon by Santa Fe, the Contracting Officer or his representative and the Government's contractor, the contractor shall schedule his work to take into consideration said types of rail traffic.

(2) Upon award of the Project contract, Santa Fe shall confer when notified with the Contracting Officer or his representative and the Government's channel contractor to determine, and agree to, a schedule of construction for the Project, specifically as it affects Santa Fe's facilities.

c. Santa Fe shall provide all lights, signs and flagging during rail traffic operations through channel construction area in accordance with Santa Fe's rail traffic regulations. Notwithstanding the terms of paragraph "b" of this Article 1, it is understood that flag protection of rail traffic and inspection service may be necessary at any time, including when overtime rates

may be applicable, and flagmen and inspector shall be provided without prior approval of Contracting officer. Santa Fe shall notify the Contracting Officer if and when such overtime rates are necessary and applicable.

d. During the progress of the work under the contract, Santa Fe shall perform such other work, or such modification of the work set forth to be performed herein, as the Contracting Officer for the Government and the authorized representative for Santa Fe may mutually determine to be necessary to accomplish the modification of the bridge, and to avoid interference with construction and operation of the project. Such mutual determination shall be evidenced by memorandum in writing.

e. Santa Fe shall procure all necessary permits and licenses; obey and abide by all applicable laws, regulations, ordinanced and other rules of the United States of America, of the State, Territory, or political subdivision thereof wherein the work is done, or of any other duly constituted public authority.

f. Santa Fe shall make such necessary schedules and specifications in connection with the work to be performed hereunder as may be required by the Contracting Officer, all of which shall be subject to approval of the Contracting Officer. Any drawings, maps, or specifications which may be furnished by the Government shall, if required by Santa Fe, be subject to approval by Santa Fe or his authorized representative before any work to which they relate is performed.

(g) Pursuant to the Water Resources Development Act of 1986, authorizing construction of the Project, all easements, rights-of-way, or other interests in real property necessary for the construction of the Channel

Project at the location shown on Exhibit "A" and preliminary plan shown on Exhibit "B" are to be provided by responsible local interests, without cost to the Government and without cost to Santa Fe. Riverside County Flood Control and Water Conservation District is acting for such local interests. Santa Fe, without cost to the Government and without cost to Santa Fe, shall make all necessary arrangements with, and convey to or obtain from the Riverside County Flood Control and Water Conservation District for any easements, rights-of-way or other interests in land which may be required for the performance of the work under this contract and for the construction of the Bridge Project to eliminate the interference of Santa Fe's facilities with the construction, completion, and operation of the Channel Project. Santa Fe will convey to the Riverside County Flood Control and Water Conservation District of Riverside County a flowage easement or subordinate its interests within the Project boundary for the operation and maintenance of the completed Channel Project.

(h) The work by Santa Fe's forces provided for in this agreement will not be commenced at the Bridge Project site until authorization to proceed is made by the Government in writing. Santa Fe may purchase and stockpile material in advance of construction and subsequent to approval of plans and specifications by the Contracting Officer for work outlined in said Exhibit "B".

ARTICLE 2. OBLIGATIONS OF THE GOVERNMENT

a. Subject to the availability of funds, the Government shall reimburse Santa Fe for all costs (except for land or easement which is a responsibility of the local sponsor) expended in connection with the Bridge Project provided in ARTICLE 1 hereof, in accordance with the provisions of paragraphs 4, 5, 6, and 7 and Attachment 1, of Section 3, Chapter 4, Volume 1 of the Federal-Aid

Highway Program Manual published by the Federal Highway Administration, U.S. Department of Transportation and any revisions thereof or amendments thereto, which said Manual is hereby incorporated in and made a part of this agreement by reference. The Government shall reimburse Santa Fe for such costs within a period of ninety (90) days after receipt of each bill accompanied by invoices properly certified by Santa Fe, in quadruplicate, supported by such evidence of payment made by Santa Fe as may be required by the Contracting Officer. All original time cards or payrolls, material records, and accounts for all charges and expenditures for which reimbursement will be claimed from the Government shall be available for a period of three (3) years after completion of the work by Santa Fe to allow the Government to check and audit the invoices submitted by Santa Fe. So far as practicable, separate records shall be maintained by Santa Fe on all items and accounts which shall constitute the basis of information from which the invoices will be prepared. The total amount to be paid by the Government to Santa Fe, for the Bridge Project, is estimated at $207,000 as shown on said Exhibit "C".

b. The Government shall at its own expense, furnish all services, labor, materials, tools and equipment necessary to review the Santa Fe designed Bridge Project for reasonableness of costs and will assure that item costs are not excessive.

c. Subject to the availability of funds:

(1) The Government shall reimburse Santa Fe for the work that may be required under Article 1.b.(2)(i) and 1.b.(2)(j) at such time as the work is performed, based on notice to the Contracting Officer of the date such work was performed.

(2) At the request of Santa Fe, partial payments shall be made during the performance of the work, for expenditures made for plant, labor and materials, upon submission by Santa Fe of its invoices to the Government for such expenditures. This provision shall not be construed as relieving Santa Fe from responsibility for all materials and work where such payments have been made, or for restoration of any damaged work not caused by the Government, or as a waiver of the right of the Government to require complete fulfillment of all reasonable terms of this contract.

(3) Any inspection and flagging costs incurred by Santa Fe incidental to construction of the Channel Project by the Government's contractor will be paid for by the Government under this contract.

d. In general, the Government shall:

(1) Furnish plans and specifications for said Channel Project construction at location shown on Exhibit "A" and preliminary plan shown on Exhibit "B". Five sets of said plans, and three copies of specifications shall be submitted to Santa Fe for approval prior to commencement of construction. After having been approved by both parties hereto, said plans and specifications are hereby adopted and incorporated into this agreement by reference.

(2) Include in its design for the Channel Project a method of protecting Santa Fe's proposed concrete box structure and embankments from scour.

(3) Make any and all arrangements, through Riverside County, that may be necessary to secure the location or relocation of wire lines, pipelines and other facilities owned by private persons, companies, corporations, political subdivisions or public utilities other than the Santa Fe which it may be found necessary to locate or relocate in any manner whatsoever due to the construction of said Channel Project.

(4) Construct the Channel Project in such a manner as not to interfere with the safe operation of Santa Fe's line of railroad.

(5) Require its Contractor, or Contractors, to notify Santa Fe 48 hours in advance of any blasting, so that proper flagging protection may be provided to prevent damage to Santa Fe's trains or property.

(6) Incorporate in each prime contract for construction of the Channel Project, or the specifications therefor, the provisions entitled "Relations with Railway Company", set forth in Exhibits "D", "D-1", and "D-2" attached hereto and made a part hereof.

(7) Except as hereinafter otherwise provided, all work to be done hereunder by the Government in the construction of said Channel Project will be done pursuant to a contract or contracts to be let by the Government, and all such contracts shall provide:

(a) That all work performed thereunder, within the limits of Santa Fe's right-of-way shall be performed in a good and workmanlike manner and in accordance with plans and specifications approved by Santa Fe and only those changes or modifications during construction that affect Santa Fe's safety or operations shall be subject to approval by Santa Fe.

(b) That no work shall be commenced over, under, or adjacent to Santa Fe's tracks until each of the prime contractors employed in connection with said work shall have (i) executed and delivered to Santa Fe a letter agreement in the form of said Exhibit "D-1", and (ii) delivered to and secured the approval by Santa Fe of the insurance required by said Exhibit "D-2".

(8) That the construction of the Channel Project shall not be commenced by the Government's Contractor until the Government shall have given written notice to the Assistant General Manager-Engineering, of Santa Fe, which notice shall state the time that operations for construction of the Channel Project shall begin.

ARTICLE 3. SALVAGE.

Santa Fe shall use such materials, equipment and supplies from the facilities existing as of the date of this contract as can be placed in the Bridge Project under the terms of this contract. Any existing materials, equipment, and supplies, or any part thereof, not so utilized, may be abandoned in accordance with the procedures set forth below:

a. If, in the opinion of the Contracting Officer, the existing facilities to be abandoned by Santa Fe will not interfere with the construction, operation, and maintenance of the Channel Project, then such facilities need not be removed by Santa Fe, but may be left in place in a condition satisfactory to the Contracting Officer.

b. If, in the opinion of the Contracting Officer, the existing facilities to be abandoned by Santa Fe will interfere with the construction, operation, and maintenance of the Channel Project, such facilities shall be removed and

disposed of by Santa Fe with its forces or pursuant to a method of competitive bidding or negotiation satisfactory to the Contracting Officer. The salvage value of such removed materials, equipment, and supplies, as determined by the method of disposal utilized by Santa Fe, shall be credited to the Government in the form of a deduction to be made from the cost properly charageable to the work to be performed under Article 1 of this contract.

c. In the event Santa Fe, with the approval of the Contracting Officer, elects not to remove and dispose of the facilities to be abandoned, the Government, at its expense, may remove such facilities in connection with the construction of the Channel Project and provide for its disposal.

ARTICLE 4. BETTERMENTS

Santa Fe agrees that the Bridge Project to be accomplished under this contract will provide Santa Fe with facilities equal in service and utility to those now in existence. The work covered under the scope of this contract does not constitute a betterment.

ARTICLE 5. OWNERSHIP AND CONDUCT OF THE WORK

a. The Bridge Project facilities constructed under this contract shall be the property of Santa Fe. Said facilities so modified shall conform to plans and specifications previously approved by the Government. Santa Fe shall be responsible for maintenance of its bridge structure and bridge supporting substructure. Maintenance of the channel side slopes and channel invert, including invert through the bridge structure will be the responsibility of the Flood Control District of Riverside County.

b. The Government may award other contracts for other work in the same vicinity. Santa Fe will cooperate fully with the Government and/or Government Contractors and the Government Contractors will cooperate with Santa Fe to the end that the work of the respective parties may be handled in an efficient manner.

c. If the Government awards another contract in the same vicinity, the Government Contractors shall comply with Santa Fe's clearance and insurance requirements contained in said Exhibits "D", "D-1", and "D-2".

ARTICLE 6. INTERFERENCE

a. Santa Fe agrees that so long as the Channel Project is operated and maintained for the purpose as described herein, that the facilities as modified, rearranged or altered pursuant to this contract shall not be so further altered or modified nor other facilities constructed by Santa Fe, so as to interfere with the operation of the Channel Project.

b. Notwithstanding paragraph "a" of this Article 6, that if Santa Fe shall deem it necessary or desirable in the future, in the performance of its duty as a common carrier, to make bridge repairs, to raise or lower the grade or change the alignment of its track or to lay additional track or tracks or to build other facilities in connection with the operation of its railroad, Santa Fe shall have full right to make such changes or additions, provided such changes or additions do not alter the Channel Project herein proposed to be constructed and provided further, however, that should it become necessary or desirable in the future to change, alter, or reconstruct the bridge or the channel to accommodate a railroad project, such alteration or reconstruction

shall be pursuant to an agreement to be entered into between the parties hereto, or their assigns, and if an agreement cannot be reached, pursuant to such action as is authorized by law.

ARTICLE 7. INSPECTION AND ACCEPTANCE

a. Santa Fe shall have the right to inspect the work to be performed hereunder by the Government at any time during its progress and to make final inspection upon completion thereof. Failure of Santa Fe to object within twenty (20) days after final inspection shall indicate satisfactory performance of the contract by the Government.

b. The Government shall provide Santa Fe channel with channel construction schedules, and Santa Fe shall have the right to inspect the channel construction in progress, for conformance to the aforementioned Channel Project plans and specifications.

ARTICLE 8. RELEASE

Santa Fe agrees, upon completion of the Bridge Project provided herein, to accept the payment provided for in Article 2 above as full and just compensation for any and all damages that have been caused to the facilities altered or modified hereunder and does hereby release the Government from any and all causes of action, suits-at-law or equity or claims or demands, and from any liability of any nature whatsoever for and on account of any damages to said right-of-way and facilities modified or altered hereunder. Santa Fe also agrees to hold and save the Government harmless from any liability to third parties arising from the design, construction, and maintenance of the Bridge Project which is not due to the fault or negligence of the Government.

ARTICLE 9. COMPLETION

Santa Fe will commence the work hereunder within 5 days from date of receipt of notice to proceed and complete the work within 30 days after the completion of all required work by the Government. The Government is contractor on Bridge No. 24.94.

ARTICLE 10. DISPUTES

a. This contract is subject to the Contract Disputes Act of 1978 (41 U.S.C. 601-613) (the Act).

b. Except as provided in the Act, all disputes arising under or relating to this contract shall be resolved under this clause.

c. "Claim," as used in this clause, means a written demand or written assertion by one of the contracting parties seeking, as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of contract terms, or other relief arising under or relating to this contract. A claim arising under a contract, unlike a claim relating to that contract, is a claim that can be resolved under a contract clause that provides for the relief sought by the claimant. However, a written demand or written assertion by Santa Fe seeking the payment of money exceeding $50,000 is not a claim under the Act until certified as required by subparagraph (d)(2) below. A voucher, invoice, or other routine request for payment that is not in dispute when submitted is not a claim under the Act. The submission may be converted to a claim under the Act, by complying with the submission and certification requirements of this clause, if it is disputed either as to liability or amount or is not acted upon in a reasonable time.

(1) A claim by Santa Fe shall be made in writing and submitted to the Contracting Officer for a written decision. A claim by the Government against Santa Fe shall be subject to a written decision by the Contracting Officer.

(2) For Santa Fe claims exceeding $50,000, the Santa Fe shall submit with the claim a certification that--

(i) The claim is made in good faith;

(ii) Supporting data are accurate and complete to the best of the Santa Fe's knowledge and belief; and

(iii) The amount requested accurately reflects the contract adjustment for which the Santa Fe believes the Government is liable.

(3) The certification shall be executed by Santa Fe's General Manager-Engineering

d. For Santa Fe claims of $50,000 or less, the Contracting Officer must, if requested in writing by Santa Fe, render a decision within 60 days of the request. For Santa Fe-certified claims over $50,000, the Contracting Officer must, within 60 days, decide the claim or notify the Santa Fe of the date by which the decision will be made. Any failure by the Contracting Officer to issue a decision on a contract claim within the period provided above, or a later time deemed reasonable by the Board of Contract Appeals, will be deemed to be a decision by the Contracting Officer denying the claim.

e. The Contracting Officer's decision shall be final unless Santa Fe appeals or files a suit as provided in the Act.

f. The Government shall pay interest on the amount found due and unpaid from (1) the date the Contracting Officer receives the claim (properly certified if required), or (2) the date payment otherwise would be due, if that date is later, until the date of payment. Simple interest on claims shall be paid at the rate, fixed by the Secretary of the Treasury as provided in the Act, which is applicable to the period during which the Contracting Officer receives the claim and then at the rate applicable for each 6-month period as fixed by the Treasury Secretary during the pendency of the claim.

g. Santa Fe shall proceed diligently with performance of this contract, pending final resolution of any request for relief, claim, appeal, or action arising under the contract, and comply with any decision of the Contracting Officer.

ARTICLE 11. COVENANT AGAINST CONTINGENT FEES

a. Santa Fe warrants that no person or agency has been employed or retained to solicit or obtain this contract upon an agreement or understanding for a contingent fee, except a bona fide employee or agency. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability or, in its discretion, to deduct from the contract price or consideration, or otherwise recover, the full amount of the contingent fee.

b. "Bona fide agency," as used in this clause, means an established commercial or selling agency, maintained by Santa Fe for the purpose of securing business, that neither exerts nor proposes to exert improper

influence to solicit or obtain Government contracts nor holds itself out as being able to obtain any Government contract or contracts through improper influence.

c. "Bona fide employee," as used in this clause, means a person, employed by Santa Fe and subject to the Santa Fe's supervision and control as to time, place, and manner of performance, who neither exerts nor proposes to exert improper influence to solicit or obtain Government contracts nor holds out as being able to obtain any Government contract or contracts through improper influence.

d. "Contingent fee," as used in this clause, means any commission, percentage, brokerage, or other fee that is contingent upon the success that a person or concern has in securing a Government contract.

e. "Improper influence," as used in this clause, means any influence that induces or tends to induce a Government employee or officer to give consideration or to act regarding a Government contract on any basis other than the merits of the matter.

ARTICLE 12. OFFICIALS NOT TO BENEFIT (1984 APR) FAR 52.203-1

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit arising from it. However, this clause does not apply to this contract to the extent that this contract is made with a corporation for the corporation's general benefit.

ARTICLE 13. GRATUITIES

a. The right of the Santa Fe to proceed may be terminated by written notice if, after notice and hearing, the agency head or a designee determines that Santa Fe, its agent, or another representative--

(1) Offered or gave a gratuity (e.g., an entertainment or gift) to an officer, official, or employee of the Government; and

(2) Intended, by the gratuity, to obtain a contract or favorable treatment under a contract.

b. The facts supporting this determination may be reviewed by any court having lawful jurisdiction.

c. If this contract is terminated under paragraph (a) above, the Government is entitled--

(1) To pursue the same remedies as in a breach of the contract; and

(2) In addition to any other damages provided by law, to exemplary damages of not less than three nor more than ten times the cost incurred by the Contractor in giving gratuities to the person concerned, as determined by the agency head or a designee. (This subparagraph (c)(2) is applicable only as this contract uses money appropriated to the Department of Defense.)

d. The rights and remedies of the Government provided in this clause shall not be exclusive and are in addition to any other rights and remedies provided by law or under this contract.

ARTICLE 14. EQUAL OPPORTUNITY

a. If, during any 12-month period (including the 12 months preceding the award of this contract), Santa Fe has been or is awarded nonexempt Federal contracts and/or subcontracts that have an aggregate value in excess of $10,000, Santa Fe shall comply with subparagraphs (b)(1) through (11) below. Upon request, Santa Fe shall be provided information necessary to determine the applicability of this clause.

b. During performing this contract, Santa Fe agrees as follows:

(1) Santa Fe shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(2) Santa Fe shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. This shall include, but not be limited to, (i) employment, (ii) upgrading, (iii) demotion, (iv) transfer, (v) recruitment or recruitment advertising, (vi) layoff or termination, (vii) rates of pay or other forms of compensation, and (viii) selection for training, including apprenticeship.

(3) Santa Fe shall post in conspicuous places available to employees and applicants for employment, the notices to be provided by the Contracting Officer that explain this clause.

(4) Santa Fe shall, in all solicitations or advertisement for employees placed by or on behalf of Santa Fe, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(5) Santa Fe shall send, to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, the notice to be provided by the Contracting Officer advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees, and applicants for employment.

(6) Santa Fe shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(7) Santa Fe shall furnish to the contracting agency all information required by Executive Order 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor, Standard Form 100 (EEO-1), or any successor form, is the prescribed form to be filed within 30 days following the award, unless filed within 12 months preceding the date of award.

(8) Santa Fe shall permit access to its books, records, and accounts by the contracting agency or the Office of Federal Contract Compliance Programs (OFCCP) for the purposes of investigation to ascertain Santa Fe's compliance with the applicable rules, regulations, and orders.

(9) If the OFCCP determines that Santa Fe is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, this contract may be canceled, terminated, or suspended in whole or in part and Santa Fe may be declared ineligible for further Government contracts, under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against Santa Fe as provided in Executive Order 11246, as amended, the rules, regulations, and orders of the Secretary of Labor, or as otherwise provided by law.

(10) Santa Fe shall include the terms and conditions of subparagraph (b)(1) through (11) of this clause in every subcontract or purchase order that is not exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subcontractor or vendor.

(11) Santa Fe shall take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing these terms and conditions, including sanctions for noncompliance; provided, that if Santa Fe becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of any direction, Santa Fe may request the United States to enter into the litigation to protect the interests of the United States.

c. Notwithstanding any other clause in this contract, disputes relative to this clause will be governed by the procedures in 41 CFR 60-1.1.

ARTICLE 15. DEFINITIONS (ALTERNATE I) (1984 APR) (DEVIATION) FAR 52.202-1 (ECI 7-070 and 7-072)

a. The term "head of the agency" or "Secretary" as used herein means the Secretary of the Army; and the term "his duly authorized representative" means the Chief of Engineers, Department of the Army, or an individual or board designated by him.

b. "Contracting Officer" means a person with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings. The term includes certain authorized representatives of the Contracting Officer acting within the limits of their authority as delegated by the Contracting Officer.

c. The agency board of contract appeals having jurisdiction over all appeals from final decisions of the Contracting Officer under the Contract Disputes Act of 1978 is the Corps of Engineers Board of Contract Appeals, Office of the Chief of Engineers, Pulaski Building, 20 Massachusetts Avenue, N.W., Washington, D.C. 20314.

ARTICLE 16. AUTHORIZED REPRESENTATIVE OF THE CONTRACTING OFFICER

The Area Engineer is the authorized representative of the Contracting Officer for the purpose of issuing instructions pursuant to requirements for changes in drawings, schedules and specifications previously approved by the Contracting Officer and the Santa Fe, provided that such modifications and changes do not involve a change in amount of the contract.

ARTICLE 17. APPROVAL

This contract shall be subject to the written approval of the South Pacific Division Engineer or his authorized representatives, and the contract shall not be binding until so approved.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

By_____
Contracting Officer

THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY

By_____
(Santa Fe)

I, _____, certify that I am the Assistant Secretary of the corporation named as Santa Fe herein; that _____, who signed this contract on behalf of the Santa Fe was then _____ of said corporation and is duly authorized to execute contractual documents.

IN WITNESS WHEREOF, I have hereunto affixed my hand and the seal of said corporation this ____ day of _____, ____.

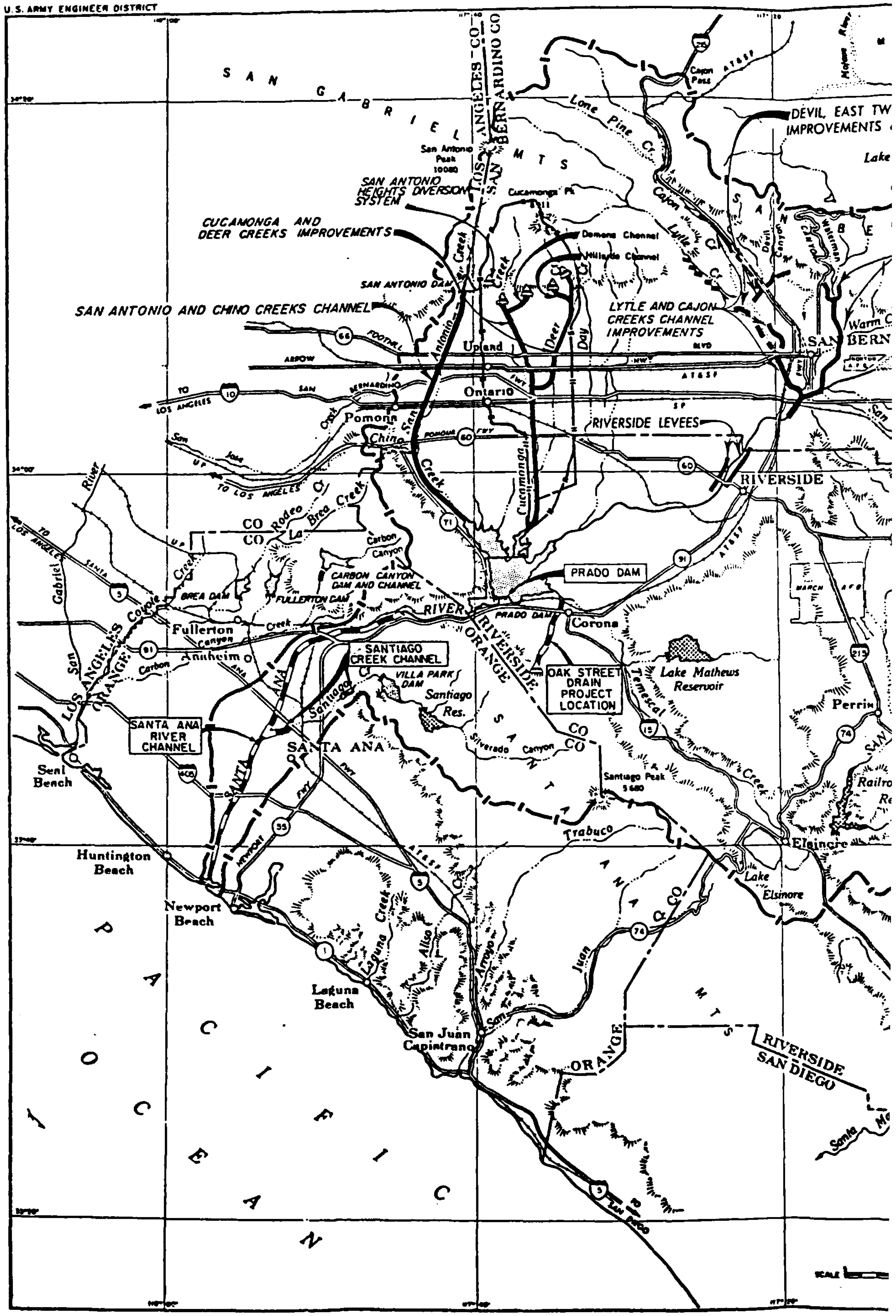
_____

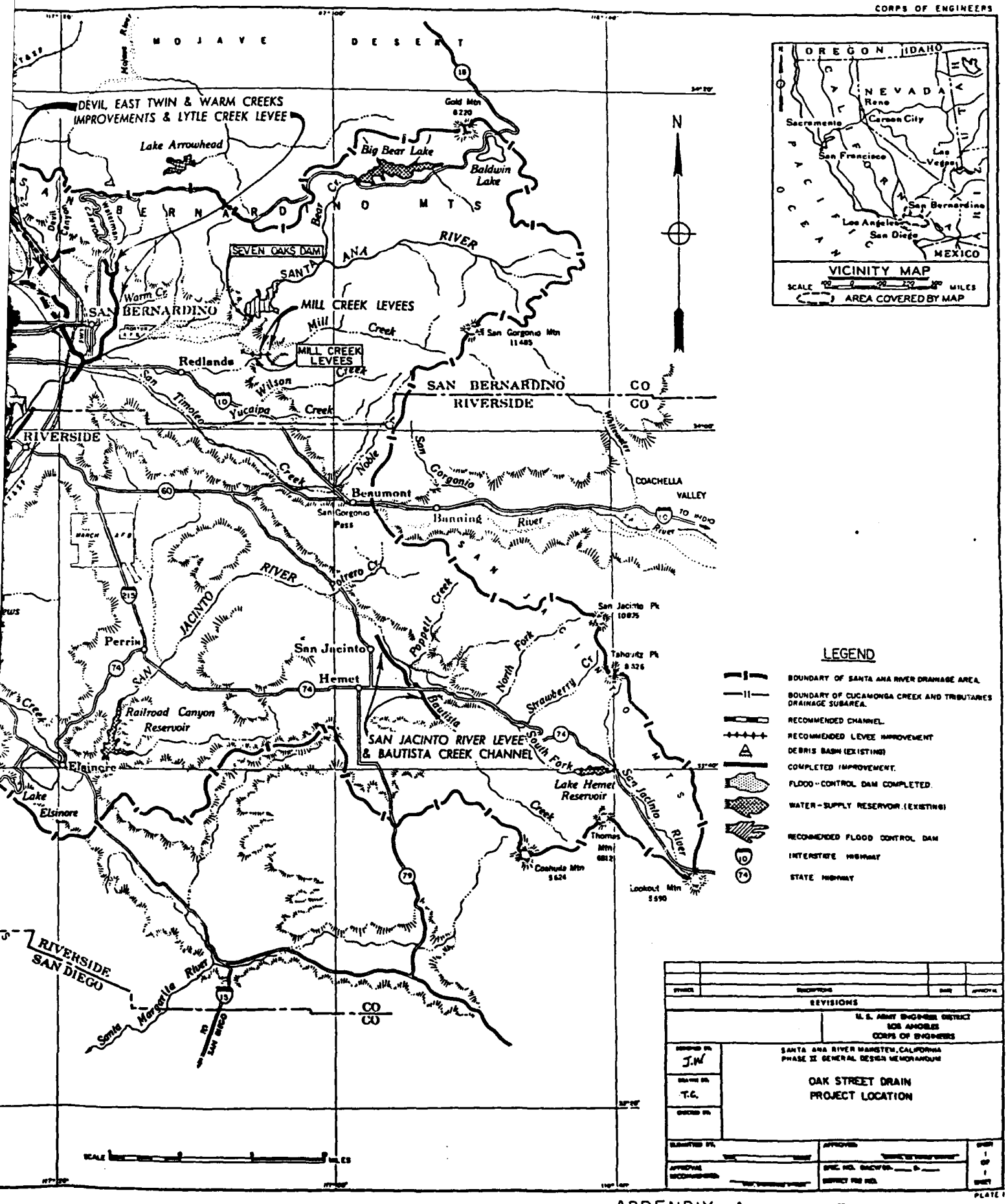
Assistant (Secretary)

(Corporate Seal)

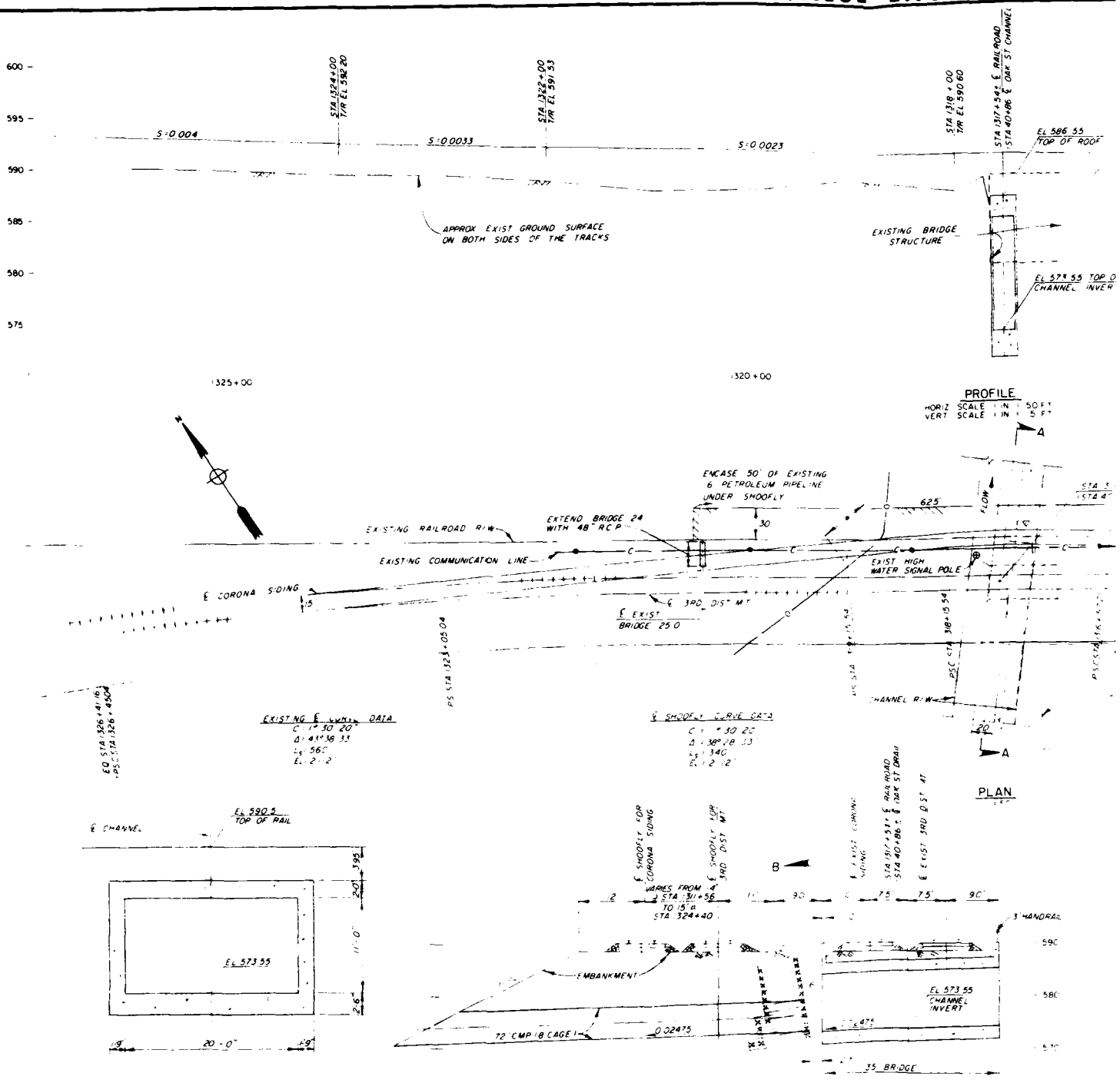
Exhibits

A	Flood Control Plan, Bridge and Channel Project Locations
B	Bridge and Channel Project, Plan, Profile and Details
C	Cost Estimate
D	Relations with Railway Company
D-1	Agreement Between the Atchison, Topeka and Santa Fe Railway Company and the Contractor
D-2	Railroad Protective Insurance


U.S. ARMY ENGINEER DISTRICT
SAN GABRIEL MTS
LOS ANGELES CO
SAN BERNARDINO CO
San Antonio Peak 10080
SAN ANTONIO HEIGHTS DIVERSION SYSTEM
Cucamonga Pk
CUCAMONGA AND DEER CREEKS IMPROVEMENTS
Demens Channel
Hillside Channel
SAN ANTONIO DAM
SAN ANTONIO AND CHINO CREEKS CHANNEL
LYTLE AND CAJON CREEKS CHANNEL IMPROVEMENTS
DEVIL EAST TW
IMPROVEMENTS
Lone Pine Cr
Cajon Pass
Upland
Ontario
Pomona
RIVERSIDE LEVEES
RIVERSIDE
PRADO DAM
CARBON CANYON DAM AND CHANNEL
BREA DAM
FULLERTON DAM
Fullerton
Anaheim
SANTIAGO CREEK CHANNEL
VILLA PARK DAM
OAK STREET DRAIN PROJECT LOCATION
Corona
Lake Mathews Reservoir
SANTA ANA RIVER CHANNEL
SANTA ANA
Seal Beach
Santiago Peak 5680
Huntington Beach
Newport Beach
Laguna Beach
San Juan Capistrano
Elsinore
Lake Elsinore
Perris
RIVERSIDE
SAN DIEGO
ORANGE
PACIFIC OCEAN
SANTA ANA MTS



APPENDIX A EXHIBIT A



DESIGN DATA
LIVE LOAD - COOPER E-80
EST WT OF EARTH - 136 pcf

CONCRETE	REINF STEEL
f'c = 4000 psi	Grade 60
YIELD STRENGTH	RE-BAR QUANTITIES
fy = 48,000 psi	Est 125 lb/cy of concrete

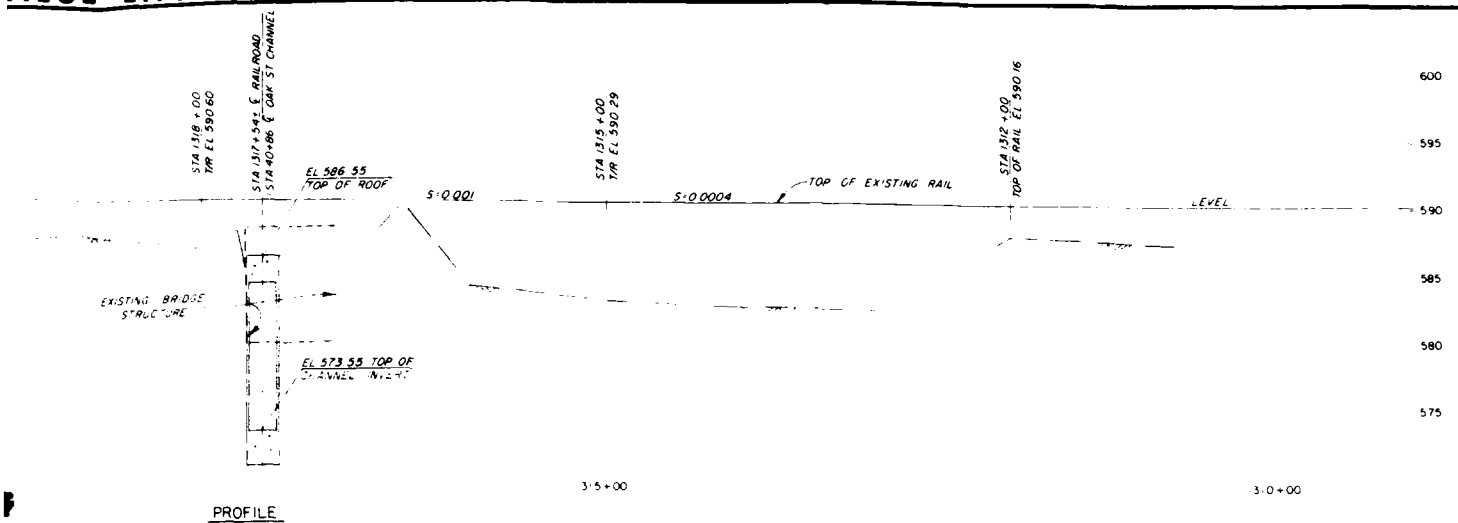
GENERAL NOTES

SANTA FE RAILWAY COMPANY SHALL BE RESPONSIBLE FOR THE FOLLOWING ITEMS OF WORK

1 MAIN LINE
- (A) CONSTRUCT AND REMOVE 763 TRACK FT OF 136# TRACK
- (B) LINE OVER AND LINE BACK 825 TRACK FT OF 136# TRACK
- (C) REMOVE AND REPLACE 265 TRACK FT OF 130# TRACK

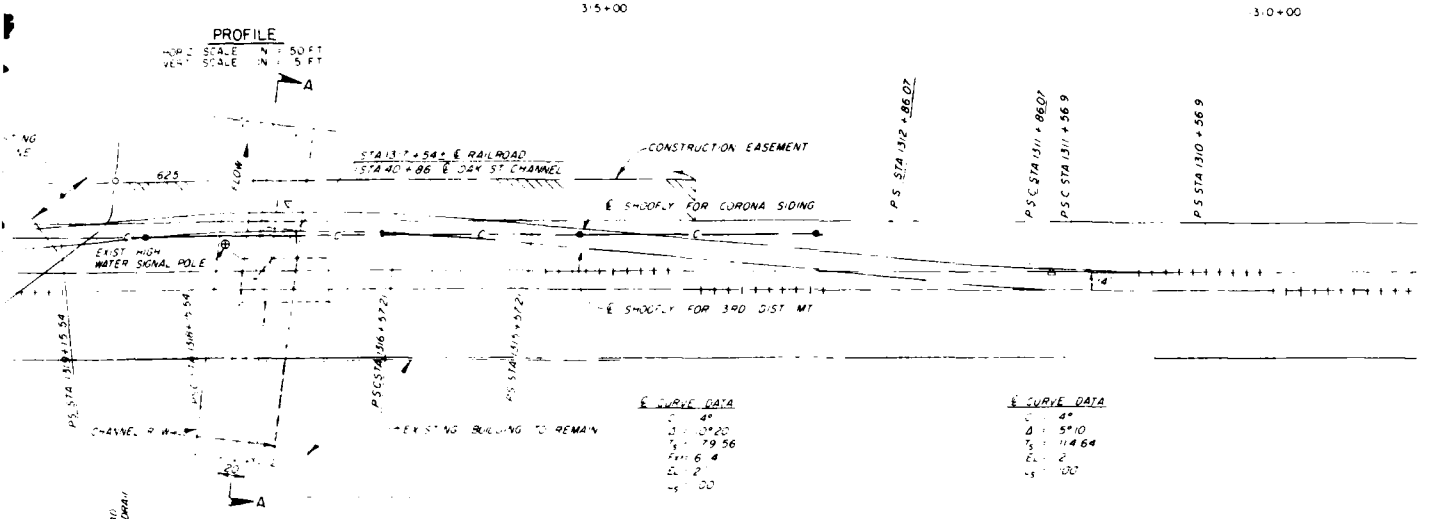
2 CORONA SIDING
- (A) CONSTRUCT AND REMOVE 763 TRACK FT OF 90# TRACK
- (B) LINE OVER AND LINE BACK 825 TRACK FT OF 90# TRACK
- (C) REMOVE AND REPLACE 265 TRACK FT OF 90# TRACK

3 EXTEND BRIDGE 25.0 BY 24 FEET WITH 48" RCP
4 RELOCATE 4 COMMUNICATION POLES AND RAISE WIRES AS NECESSARY
5 RELOCATE HIGH WATER SIGNAL POLE ON WEST END OF BRIDGE

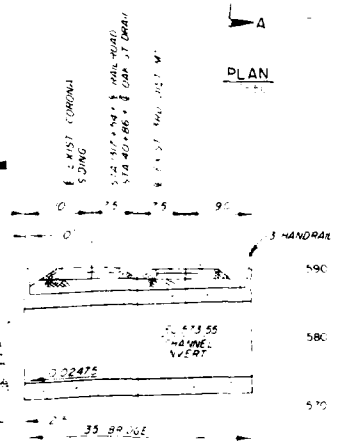


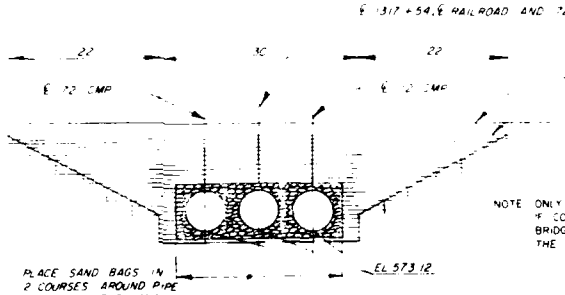
PROFILE

HOR SCALE IN = 50 FT
VERT SCALE IN = 5 FT



PLAN





NOTE ONLY 2 - 72 CMP INCL PIPE PROVIDED IF CONSTRUCTION OF THE RAILROAD BRIDGE IS TO BE COMPLETED DURING THE SUMMER DRY MONTHS

SECTION B-B

...MANY SHALL BE RESPONSIBLE FOR
...F WORK
...STRUCT AND REMOVE 763 TRACK FT OF 136° TRACK
...VE OVER AND LINE BACK 825 TRACK FT OF 136° TRACK
...VE AND REPLACE 265 TRACK FT OF 130° TRACK
...STRUCT AND REMOVE 763 TRACK FT OF 90° TRACK
...VE OVER AND LINE BACK 825 TRACK FT OF 90° TRACK
...VE AND REPLACE 265 TRACK FT OF 90° TRACK
...BY 24 FEET WITH 48" RCP
...CATION POLES AND RAISE WIRES AS NECESSARY
...WATER SIGNAL POLE ON WEST END OF BRIDGE

DATUM IS NATIONAL GEODETIC VERTICAL DATUM OF 1929

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY

DRAWN BY
J CASTRO

CHECKED BY

SANTA ANA RIVER MAINSTEM, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
ALTERATION OF ATCHISON, TOPEKA AND SANTA FE RAILWAY BRIDGE

SUBMITTED BY:

DATE APPROVED

SPEC NO. DACW09-____-B-____

DISTRICT FILE NO.

SHEET
OF

APPENDIX A EXHIBIT B

EXHIBIT "C"

COST ESTIMATES

(Oct 1987 Price Levels)

Alteration of Atchison, Topeka and Santa Fe Bridge

Crossing Oak Street Drain, Corona, California

Mobilization & Demobilization			$ 8,200
Engineering and inspection (Shooflies)			$ 3,570
Engineering & inspection (Main Tracks)			8,500
Track (Shooflies)	Labor & Material		76,900
Track (Main Tracks)	Labor & Material		38,400
Signal (Shooflies)	Labor & Material		23,550
Signal (Main Tracks)	Labor & Material		23,320
Contingencies			18,240
Estimated cost of labor and material (sum)			200,680
Auditing and billing			1,740
Equipment rental inc. work train			28,190
Credit for material recovered & returned to stock:			
Track material	$ 24,280		
Signal material	None		
Total Credit			-24,280
Estimated cost of work to be performed by Santa Fe forces and paid for by the U.S. Corps of Engineers			$ 206,330
		Say	207,000

EXHIBIT "D"

RELATIONS WITH RAILWAY COMPANY

-1.01 General.--The Contractor, as a prerequisite for award, shall be satisfactory as to his responsibility and ability to perform the work over and across the property and over or under the tracks of The Atchison, Topeka and Santa Fe Railway Company.

It is expected that The Atchison, Topeka and Santa Fe Railway Company will cooperate with the Contractor to the end that the work may be handled in an efficient manner, but the Contractor shall have no claim for damages or extra compensation in the event his work is held up by the work of the Railway Company forces.

-1.02 Agreement.--Before doing any work on Railway right of way, or property, the Contractor will be required to execute and deliver to The Atchison, Topeka and Santa Fe Railway Company a letter agreement, in the form attached hereto, obligating the Contractor to provide and keep in full force and effect the insurance called for under "insurance" of these special provisions.

-1.03 Railway Requirements.-The Contractor shall cooperate with The Atchison, Topeka and Santa Fe Railway Company where work is over or under the tracks, or within the limits of Railway property in order to expedite the work and to avoid interference with the operation of Railway equipment.

The Contractor shall comply with the rules and regulations of Railway or the instructions of its representatives in relation to the proper manner of protecting the tracks and property of Railway and the traffic moving on such tracks, as well as the wires, signals and other property of Railway, its tenants or licensees, at and in the vicinity of the work during the period of construction.

The Contractor shall perform his work in such manner and at such times as shall not endanger or interfere with the safe and timely operation of the tracks and property of Railway and the traffic moving on such tracks, as well as wires, signals and other property of Railway, its tenants or licensees, at or in the vicinity of the work.

The Contractor shall take protective measures necessary to keep Railroad facilities, including track ballast, free of sand or debris resulting from his operations. Any damage to Railroad facilities resulting from contractor's operations will be repaired or replaced by Railroad and the cost of such repairs or replacement shall be deducted from the contractor's progress and final pay estimates.

The Contractor shall not pile or store any materials, park or use his equipment closer to the center of the nearest Railway track, or overhead lines, than permitted by the following clearances:

10'-0"	Horizontally from center line of track.
22'-6"	Vertically above top of rail
27'-0"	Vertically above top of rail for electric wires carrying less than 750 volts.
28'-0"	Vertically above top of rail for electric wires carrying 750 volts to 15,000 volts.
30'-0"	Vertically above top of rail for electric wires carrying 15,000 volts to 20,000 volts.
34'-0"	Vertically above top of rail for electric wires carrying more than 20,000 volts.

Any infringement on the above clearances or walkways due to the Contractor's operations shall be submitted to the Railway and to the Engineer and shall not be undertaken until approved by the Railway, and until the Engineer has obtained any necessary authorization from the Public Utilities Commission for the infringement. No extra compensation will be allowed in the event the Contractor's work is delayed pending Railway approval, and Public Utilities Commission authorization.

In the case of impaired vertical clearance above top of rail, Railway shall have the option of installing tell-tales or other protective devices railway deems necessary for protection of railway trainmen or rail traffic.

The details of construction affecting the Railway tracks and property not included in the contract plans shall be submitted to the Railway for approval before such work is undertaken.

If the Contractor desires to move his equipment or materials across Railway's tracks he shall obtain permission from Railway and, should it be required, the Contractor shall obtain a private crossing agreement. The crossing installation for the use of the Contractor, if required, shall be at the expense of the Contractor.

The Contractor shall, upon completion of the work covered by this contract to be performed by the Contractor upon the premises or over or beneath the tracks of Railway, promptly remove from the premises of Railway all of Contractor's tools, implements and other materials, whether brought upon said premises by said Contractor or any Sub-contractor, employee or agent of Contractor or of any Sub-contractor, and cause said premises to be left in a clean and presentable condition.

-1.04 Protection of Railroad Facilities:-

(1) Upon advance notification of not less than 24 hours by contractor, Railroad representatives, conductors, flagmen or watchmen will be provided by Railroad to protect it facilities, property and movements of its trains or engines. In general, Railroad will furnish such personnel or other protective services:

(a) When any part of any equipment is standing or being operated within 10 feet, measured horizontally, from centerline of any track on which trains may operate, or when any erection or construction activities are in progress within such limits, regardless of elevation above or below track.

(b) For any excavation below elevation of track subgrade if, in the opinion of Railroad's representative, track or other railroad facilities may be subject to settlement of movement.

(c) For any clearing, grubbing, grading, or blasting in proximity to Railroad facilities which, in the opinion of Railroad's representative, may endanger Railroad facilities or operations.

(2) Railroad will furnish such personnel or other protective services when, in the opinion of Railroad's representative, Railroad facilities, including, but not limited to, tracks, buildings, signals, wire lines or pipe lines, may be endangered.

(3) Information as to the Railroad employees which may be required to provide protection to Railroad facilities is as follows:

(a) Inspector $250.00 per day plus expenses

(b) Flagman $200.00 per day plus expenses

The above rates are for estimating only, and rates in effect at the time of construction will be used for overtime, number of hours to be paid for, and travel, meal and lodging allowances will be in accordance with labor union agreements in effect at the time the work is performed.

To all direct labor costs, there shall be added additional charges for Vacation Allowance; Holiday Pay; Health and Welfare; Railroad Retirement and Unemployment Taxes; Public Liability, Property Damage, and Workman's Compensation Insurance; and Accounting and Billing.

The cost of all Railroad personnel, equipment, and facilities deemed necessary by the Railway and provided by the Railway for the protection of Railroad facilities and trains during the period of construction within Railway right-of-way and the cost of installing protective devices in the case of impaired clearance shall be borne by the Government . The Contractor shall be responsible for payment of all costs incurred for any damages to Railroad roadbed, track and/or appurtenances thereto, resulting from use, occupancy, presence of its employees or agents on or about the construction site.

(4) Railroad will submit its final bills for flagging and related services to Government after completion of the project. Government will pay all flagging charges.

-1.05 Work by Railway Company. - Railroad will rearrange its tracks, telephone, telegraph, and signal lines and appurtenances, and will perform any other work in connection therewith, except grading to be done by others.

EXHIBIT "D-1"

Agreement between
THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY
AND THE CONTRACTOR

The Atchison, Topeka and Santa Fe Railway Company
One Santa Fe Plaza, 5200 E. Sheila Street
Los Angeles, CA 90040

Attention: General Manager

Gentlemen:

The undersigned has entered into a contract dated _____, 19___, with the _____, for the performance of certain work in connection with _____

_____

in the performance of which work the undersigned will necessarily be required to conduct operations within your right of way and property. The Contract provides that no work shall be commenced within your right of way or property until the contractor employed in connection with said work for Government shall have executed and delivered to you a letter agreement in the form hereof and shall have provided insurance of the coverage and limits specified in said contract. If this letter agreement is executed by other than the Owner, General Partner, President or Vice President of the undersigned firm, evidence is furnished to you herewith certifying that the signatory is empowered to execute this agreement for the firm.

Accordingly, as one of the inducements to and as part of the consideration for your granting permission to the undersigned to enter upon your right of way or property for the performance of so much of the work as is necessary to be done within your right of way or property, the undersigned, effective on the date of the contract with the Government has agreed and does hereby agree with you as follows:

1. The undersigned shall indemnify and save harmless the Santa Fe, its agents and employees against all liability, claims, demands, damages, or costs for (a) death or bodily injury to persons, including without limitation the employees of the parties hereto, (b) injury to property, including without limitation, the property of the parties hereto, (c) design defects, or (d) any other loss, damage, or expense arising under either (a), (b), or (c), and all fines or penalties imposed upon or assessed against Santa Fe, and all expenses of investigating and defending against same, arising in any manner out of (1) use, occupancy or presence of the undersigned, sub-contractors, employees, or agents in, on, or about the construction site, (2) the performance, or failure to perform, by the undersigned, its subcontractors, employees, or agents, its work or any obligation under this agreement, or (3) the sole or contributing acts or omissions of the undersigned, its subcontractors, employees, or agents in, on, or about the construction site. Nothing contained in this provision is intended to, nor shall be deemed or construed to, indemnify Santa Fe from its sole negligence or willful misconduct, or that of its agents, servants or independent contractors who are directly responsible to it

2. That the undersigned will procure, and maintain in force, insurance meeting all of the requirements outlined in the special provisions for and in contract referred to in the second paragraph above, and there is handed you herewith:

(1) Original Policy in Railroad Protective Liability Form, fever of The Atchison, Topeka and Santa Fe Railway Company, One Santa Fe Plaza, 5200 East Sheila Street, Los Angeles, CA 90040, and

(2) Certificate reflecting the existence of Contractor's Public Liability and Property Damage Liability Insurance and Contractor's Protective Public Liability and Property Damage Liability Insurance,

meeting such requirements. It is further distinctly understood and agreed by the undersigned that its liability to the Railway Company herein under Paragraph 2, will not in any way be limited to the amount of insurance obtained and carried by the undersigned in connection with said contract.

3. That the undersigned will observe and comply with all the provisions, obligations and limitations to be observed by Contractor which are contained in the sub-division of the specifications of the contract referred to in the second paragraph hereof, entitled "Relations with Railway Company", which shall include, but not be limited to, payment of all costs incurred for any damages to Railroad roadbed, tracks, and/or appurtenances thereto, resulting from use, occupancy, presence of its employees or agents on or about the construction site.

Date:_____

AT&SF Railway Co.

Kindly acknowledge receipt of this letter and of the insurance policies herein provided to be furnished to you by signing and returning to the undersigned a copy of this letter, which shall thereupon constitute an agreement between us.

Yours truly,

_____

By_____

Receipt of the foregoing letter and of the policies and certificates of insurance herein provided to be furnished is hereby acknowledged this

_____day of _____, 19_____,

THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY

By_____

Its_____

EXHIBIT "D-2"

RAILROAD PROTECTIVE INSURANCE

In addition to any other form of insurance or bonds required under the terms of the contract and specifications, the Contractor will be required to carry insurance of the kinds and in the amounts hereinafter specified. Such insurance shall be approved by:

THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY

hereinafter called "Railroad" before any work is performed on Railroad property and shall be carried until all work required to be performed on or adjacent to the Railroad's property under the terms of the contract is satisfactorily completed as determined by the Engineer, and thereafter until all tools, equipment and material have been removed from Railroad's property and such property is left in a clean and presentable condition.

The insurance herein required shall be obtained by the successful bidder, and the original and certified copies of all policies as hereinafter specified shall be furnished to the Engineer.

The Contractor shall furnish the Engineer with one (1) certified copy of each of the executed policies required by 1, 2, and 3 below, and in addition, shall furnish Railroad through the Engineer, one (1) certificate reflecting the existence of the executed policies required by 1 and 2 and the original policies of the insurance required by 3 below.

A certification on such copies of insurance shall guarantee that the policy under 1 and 2 will not be amended, altered, modified, or canceled insofar as the coverage contemplated hereunder is concerned, without at least thirty (30) days notice mailed by registered mail to the Engineer and to Railroad.

Full compensation for all premiums which the Contractor is required to pay on all the insurance described hereinafter shall be considered as included in the prices paid for the various items of work to be performed under the contract, and no additional allowance will be made therefor or for additional premiums which may be required by extensions of the policies of insurance.

The approximate ratio of the estimated cost of the work over or under or within 50 feet of Railroad's tracks to the total estimated contract cost is 0.---.

1. Contractor's Public Liability and Property Damage Liability Insurance

The Contractor shall, with respect to the operations he performs within or adjacent to Railroad's property, carry regular contractor's Public Liability and Property Damage Liability Insurance providing for the same limits as specified for Railroad's Protective Public Liability and Property Damage Liability Insurance to be furnished for and in behalf of Railroad as hereinafter provided.

If any part of the work within or adjacent to Railroad's property is subcontracted, the Contractor in addition to carrying the above insurance, shall provide the above insurance in behalf of the subcontractors to cover their operations.

2. Contractor's Protective Public Liability and Property Damage Liability Insurance

The Contractor shall, with respect to the operations performed for him by Subcontractors who do work within or adjacent to Railroad's property, carry in his own behalf regular Contractor's Protective Public Liability and Property Damage Liability Insurance providing for the same limits as specified for Railroad's Protective Public Liability and Property Damage Liability Insurance to be furnished for and in behalf of Railroad as hereinafter provided.

3. Railroad's Protective Public Liability and Property Damage Liability Insurance

The Contractor shall, with respect to the operations he performs within or adjacent to Railroad's property or that of any of his subcontractors who do work within or adjacent to Railroad's property, have issued and furnished separately, policy or policies of insurance in the Railroad Protective Liability Form as hereinafter specified in favor of The Atchison, Topeka and Santa Fe Railway Company, One Santa Fe Plaza, 5200 East Sheila Street, Los Angeles, CA 90040.

Railroad Protective Liability Form

_____
(Name of Insurance Company)

DECLARATIONS:

Item 1. Named Insured:

The Atchison, Topeka and Santa Fe Railway Company
One Santa Fe Plaza, 5200 East Sheila Street
Los Angeles, CA 90040

Item 2. Policy Period:

From _____ to _____
12:01 a.m., Standard Time, at the designated job site as stated herein.

Item 3. The insurance afforded is only with respect to such of the following coverages as are indicated in Item 6 by specific premium charge or charges. The limit of the company's liability against such coverage or coverages shall be as stated herein, subject to all the terms of this policy having reference thereto.

Coverages	Limits of Liability
A Bodily Injury Liability B Property Damage Liability & C and Physical Damage to Property	$2 million Combined Single Limit per occurrence, with an aggregate limit of $6 million for the term of the policy.

Item 4. Name and Address of Contractor:

Item 5. Name and address of Government Authority for whom the work by the Contractor is being performed:

Item 6. Designation of the Job Site and Description of Work:

Premium Bases	Rates per $100 of Cost		Advance Premiums	
	Coverage A	Coverages B&C	Coverage A	Coverages B&C
Contract Cost	$	$	$	$
Rental Cost	$	$	$	$

Countersigned _____ 19____ By _____

POLICY

_____
(Name of Insurance Company)

A _____ insurance company, herein called the Company, agrees with the insured named in the declarations made a part hereof, in consideration of the payment of the premium and in reliance upon the statements in the declarations made by the named insured and subject to all of the terms of this policy:

INSURING AGREEMENTS

I. Coverage A - Bodily Injury Liability

To pay on behalf of the insured all sums which the insured shall become legally obligated to pay as damages because of bodily injury, sickness, or disease, including death at any time resulting therefrom, hereinafter called "bodily injury", either (1) sustained by any person arising out of acts or omissions at the designated job site which are related to or are in connection with the work described in Item 6 of the declarations, or (2) sustained at the designated job site by the contractor or any employee of the contractor or by any designated employee of the insured whether or not arising out of such acts or omissions.

Coverage B - Property Damage Liability

To pay on behalf of the insured all sums which the insured shall become legally obligated to pay as damages because of physical injury to or destruction of property, including loss of use of any property due to such injury or destruction, hereinafter called "property damage", arising out of acts or omissions at the designated job site which are related to or are in connection with the work described in Item 6 of the declarations.

Coverage C - Physical Damage to Property

To pay for direct and accidental loss of or damage to rolling stock and their contents, mechanical construction equipment, or motive power equipment, hereinafter called loss, arising out of acts or omissions at the designated job site which are related to or are in connection with the work described in Item 6 of the declarations; provided such property is owned by the named insured or is leased or entrusted to the named insured under a lease or trust agreement.

II. Definitions

(a) Insured - The unqualified word "insured" includes the named insured and also includes any executive officer, director or stockholder thereof while acting within the scope of his duties as such.

(b) Contractor - The word "contractor" means the contractor designated in Item 4 of the declarations and includes all subcontractors of said contractor but shall not include the named insured.

(c) Designated employee of the insured - The words "designated employee of the insured" mean:

(1) any supervisory employee of the insured at the jobsite.

(2) any employee of the insured while operating, attached to or engaged on work trains or other railroad equipment at the jobsite which are assigned exclusively to the contractor, or

(d) Contract - The word "contract" means any contract or agreement to carry a person or property for a consideration or any lease, trust or interchange contract or agreement respecting motive power, rolling stock or mechanical construction equipment.

III. Defense, Settlement, Supplementary Payments

With respect to such insurance as is afforded by this policy under coverages A and B, the Company shall:

(a) defend any suit against the insured alleging such bodily injury or property damage and seeking damages which are payable under the terms of this policy, even if any of the allegations of the suit are groundless, false or fraudulent; but the Company may make such investigation and settlement of any claims or suit as it deems expedient;

(b) pay, in addition to the applicable limits of liability:

(1) all expenses incurred by the Company, all costs taxed against the insured in any such suit and all interest on the entire amount of any judgment therein which accrues after entry of the judgment and before the Company has paid or tendered or deposited in court that part of the judgment which does not exceed the limit of the Company's liability thereon;

(2) premiums on appeal bonds required in any such suit, premiums on bonds to release attachments for an amount not in excess of the applicable limit of liability of this policy, but without obligation to apply for or furnish any such bonds;

(3) expenses incurred by the insured for such immediate medical and surgical relief to others as shall be imperative at the time of the occurrence;

(4) all reasonable expenses, other than loss of earnings, incurred by the insured at the Company's request.

IV. Policy Period, Territory

This policy applies only to occurrences and losses during the policy period and within the United States of America, its territories or possessions, or Canada.

EXCLUSIONS

This policy does not apply:

(a) to liability assumed by the insured under any contract or agreement except a contract as defined herein;

(b) to bodily injury or property damage caused intentionally by or at the direction of the insured;

(c) to bodily injury, property damage or loss which occurs after notification to the named insured of the acceptance of the work by the governmental authority, other than bodily injury, property damage or loss resulting from the existence or removal of tools, uninstalled equipment and abandoned or unused materials;

(d) Under Coverages A(1), B and C, to bodily injury, property damage or loss, the sole proximate cause of which is an act or omission of any insured other than acts or omissions of any designated employee of any insured;

(e) under Coverage A, to any obligation for which the insured or any carrier as his insurer may be held liable under any workmen's compensation, unemployment compensation or disability benefits law, or under any similar law; provided that the Federal Employers' Liability Act, U.S. Code (1946) Title 45, Sections 51-60, as amended, shall for the purposes of this insurance be deemed not to be any similar law;

(f) under Coverage B, to injury to or destruction of property (I) owned by the named insured or (II) leased or entrusted to the named insured under a lease or trust agreement.

(g)1. Under any Liability Coverage, to injury, sickness, disease, death or destruction:

(a) with respect to which an insured under the policy is also an insured under a nuclear energy liability policy issued by Nuclear Energy Liability Insurance Association, Mutual Atomic Energy Liability Underwriters or Nuclear Insurance Association of Canada, or would be an insured under any such policy but for its termination upon exhaustion of its limit of liability; or

(b) resulting from the hazardous properties of nuclear material and with respect to which (1) any person or organization is required to maintain financial protection pursuant to the Atomic Energy Act of 1954, or any law amendatory thereof, or (2) the insured is, or had this policy not been issued would be, entitled to indemnity from the United States of America, or any agency thereof, under any agreement entered into by the United States of America, or any agency thereof, with any person or organization.

2. Under any Medical Payments Coverage, or under any Supplementary-Payments provision relating to immediate medical or surgical relief, to expenses incurred with respect to bodily injury, sickness, disease or death resulting from the hazardous properties of nuclear material and arising out of the operation of a nuclear facility by any person or organization.

3. Under any Liability Coverage, to injury, sickness, disease, death or destruction resulting from the hazardous properties of nuclear material, if

(a) the nuclear material (1) is at any nuclear facility owned by, or operated by or on behalf of, an insured or (2) has been discharged or dispersed therefrom;

(b) the nuclear material is contained in spent fuel or waste any time possessed, handled, used, processed, stored, transported or disposed of by or on behalf of an insured; or

(c) the injury, sickness, disease, death or destruction arises out of the furnishing by an insured of services, materials, parts or equipment in connection with the planning, construction, maintenance, operation or use of any nuclear facility, but if such facility is located within the United States of America, its territories or possessions or Canada, this exclusion (c) applies only to injury to or destruction of property at such nuclear facility.

4. As used in this exclusion:

"Hazardous properties" include radioactive, toxic or explosive properties;

"nuclear material" means source material, special nuclear material or byproduct material;

"source material", "Special nuclear material", and "byproduct material" have the meanings given them in the Atomic Energy Act of 1954, or in any law amendatory thereof.

"spent fuel" means any fuel element or fuel component, solid or liquid, which has been used or exposed to radiation in a nuclear reactor;

"waste" means any waste material:

(1) containing byproduct material and

(2) resulting from the operation by any person or organization of any nuclear facility included within the definition of nuclear facility under paragraph (a) or (b) thereof;

"nuclear facility" means:

(a) any nuclear reactor

(b) any equipment or device designed or used for (1) separating the isotopes of uranium or plutonium, (2) processing or utilizing spend fuel, or (3) handling, processing or packaging waste;

(c) any equipment or device used for the processing, fabricating or alloying of special nuclear material if at any time the total amount of such material in the custody of the insured at the premises where such equipment or device is located consists of or contains more than 25 grams of plutonium or uranium 233 or any combination thereof, or more than 250 grams of uranium 235.

(d) any structure, basin, excavation, premises or place prepared or used for the storage or disposal of waste,

and includes the site on which any of the foregoing is located, all operations conducted on such site and all premises used for such operations;

"nuclear reactor" means any apparatus designed or used to sustain nuclearfission in a self-supporting chain reaction or to contain a critical mass of fissionable material;

"injury" or "destruction", with respect to injury to or destruction of property, the word includes all forms of radioactive contamination of property.

(h) under coverage C, to loss due to nuclear reaction, nuclear radiation or radioactive contamination, or to any act or condition incident to any of the foregoing.

CONDITIONS

(The conditions, except conditions 3, 4, 5, 7, 8, 9, 10, 11 and 12, apply to all coverages. Conditions 3, 4, 5, 7, 8, 9, 10, 11 and 12 apply only to the coverage noted thereunder.)

1. Premium The Premium bases and rates for the hazards described in the declarations, are stated therein. Premium bases and rates for hazards not so described are those applicable in accordance with the manuals in use by company. The term "contract cost" means the total cost of all work described in Item 6 of the declarations.

The term "rental cost" means the total cost to the contractor for rental of work trains or other railroad equipment, including the remuneration of all employees of the insured while operating, attached to or engaged thereon.

The advance premium stated in the declaration is an estimated premium only. Upon termination of this policy the earned premium shall be computed in accordance with the company's rules, rates, rating plans, premiums and minimum premiums applicable to this insurance. If the earned premium thus computed exceeds the estimated advance premium paid, the company shall look to the contractor specified in the declarations for any such excess; if less, the company shall return to the said contractor the unearned portion paid.

In no event shall payment of premium be an obligation of the named insured.

2. Inspection The named insured shall make available to the company records of information relating to the subject matter of this insurance.

The company shall be permitted to inspect all operations in connection with the work described in Item 6 of the declarations.

3. Limits of Liability Coverage A The limits of bodily injury liability stated in the declarations as applicable to "each person" is the limit of the company's liability for all damages, including damages for care and loss of services, arising out of bodily injury sustained by one person as the result of any one occurrence; the limit of such liability stated in the declarations as applicable to "each occurrence" is, subject to the above provisions respecting each person, the total limit of the company's liability for all such damage arising out of bodily injury sustained by two or more persons as the result of any one occurrence.

4. Limits of Liability Coverages B&C The limit of liability under Coverages B and C stated in the declarations as applicable to "each occurrence" is the total limit of the company's

arising out of physical injury to, destruction or loss of all property of one or more persons or organizations, including the loss of use of any property due to such injury or destruction under Coverage B, as the result of any one occurrence.

Subject to the above provisions respecting "each occurrence", the limit of liability under Coverages B and C stated in the declaration as "aggregate" is the total limit of the company's liability for all damages and all loss under Coverages B and C combined arising out of physical injury to, destruction or loss of property, including the loss of use of any property due to such injury or destruction under Coverage B.

Under Coverage C, the limit of the company's liability for loss shall not exceed the actual cash value of the property or if the loss is of a part thereof the actual cash value of such part, at time of loss, nor what it would then cost to repair or replace the property or such part thereof with other of like kind and quality.

5. Severality of Interests Coverages A&B — The term "the insured" is used severally and not collectively, but the inclusing herein of more than one insured shall not operate to increase the limits of the company's liability.

6. Notice — In the event of an occurrence or loss, written notice containing particulars sufficient to identify the insured and also reasonably obtainable information with respect to the time, place and circumstances thereof, and the names and addresses of the injured and of available witnesses, shall be given by or for the insured to the company or any of its authorized agents as soon as practicable. If claim is made or suit is brought against the insured, he shall immediately forward to the company every demand, notice, summons or other process received by him or his representative.

7. Assistance and Cooperation of the Insured Coverages A&B — The insured shall cooperate with the company and, upon the company's request, attend hearings and trials and assist in making settlements, securing and giving evidence, obtaining the attendance of witnesses and in the conduct of suits. The insured shall not, except at his own cost, voluntarily make any payment, assume any obligation or incur any expense other than for such immediate medical and surgical relief to others as shall be imperative at the time of accident.

8. Action Against Company Coverages A&B — No action shall lie against the company unless, as a condition precedent thereto, the insured shall have fully complied with all the terms of this policy, nor until the amount of the insured's obligation to pay shall have been finally determined either by judgment against the insured after actual trial or by written agreement of the insured, the claimant and the company.

Any person or organization or the legal representative thereof who has secured such judgment or written agreement shall thereafter be entitled to recover under this policy to the extent of the insurance afforded by this policy. No person or organization shall have any right under this policy to join the company as a party to any action against the insured to determine the insured's liability. Bankruptcy or insolvency of the insured or of the insured's estate shall not relieve the company of any of its obligations hereunder.

Coverage C — No action shall lie against the company unless, as a condition precedent thereto, there shall have been full compliance with all the terms of this policy nor until thirty days after proof of loss is filed and the amount of loss is determined as provided in this policy.

9. Insured's Duties in Event of Loss Coverage C — In the event of loss the insured shall:

(a) protect the property, whether or not the loss is covered by this policy, and any further loss due to the insured's failure to protect shall not be recoverable under this policy; reasonable expenses incurred at the company's request;
(b) file with the company, as soon as practicable after loss, his sworn proof of loss in such form and including such information as the company may reasonably require and shall, upon the company's request, exhibit the damaged property.

10. Appraisal Coverage C — If the insured and company fail to agree as to the amount of loss, either may, within 60 days after the proof of loss is filed, demand an appraisal of the loss. In such event the insured and the company shall each select a competent appriaser, and the appraisers shall select a competent and disinterested umpire. The appraisers shall state separately the actual cash value and the amount of loss and failing to agree shall submit their differences to the umpire. An award in writing of any two shall determine the amount of loss. The insured and the company shall each pay his chosen appraiser and shall bear equally the other expenses of the appraisal and umpire.

The company shall not be held to have waived any of its rights by any act relating to appraisal.

11. Payment of Loss Coverage C — The company may pay for the loss in money but there shall be no abandonment of the damaged property to the company.

12. No Benefit to Bailee Coverage C — The insured afforded by this policy shall not inure directly or indirectly to the benefit ofany carrier or bailee, other than the named insured, liable for loss to the property.

13. Subrogation — In the event of any payment under this policy, the company shall be subrogated to all the insured's right of recovery therefor against any person or organization and the insured shall execute and deliver instruments and papers and do whatever else is necessary to secure such rights. The insured shall do nothing after loss to prejudice such rights.

14. Application of Insurance — The insurance afforded by this policy is primary insurance.

15. Three Year Policy — A policy period of three years is comprised of three consecutive annual periods. Computation and adjustment of earned premium shall be made at the end of each annual period. Aggregate limits of liability as stated in this policy shall apply separately to each annual period.

16. Changes — Notice to any agent or knowledge possessed by any agent or by any other person shall not effect a waiver or a change in any part of this policy or estop the company from asserting any right under the terms of this policy; nor shall the terms of this policy be waived or changed, except by endorsement issued to form a part of this policy.

17. Assignment — Assignment of interest under this policy shall not bind the company until its consent is endorsed hereon.

18. Cancellation — This policy may be cancelled by the named insured by mailing to the company written notice stating when thereafter the cancellation shall be effective. This policy may be cancelled by the company by mailing to the named insured, contractor and governmental authority at the respective addresses shown in this policy written notice stating when not less than thirty days thereafter such cancellation shall be effective. The mailing of notice as aforesaid shall be sufficient proof of notice. The effective date and hour of cancellation stated in the notice shall become the end of the policy period. Delivery of such written notice either by the named insured or by the company shall be equivalent to mailing.

If the named insured cancels, earned premium shall be computed in accordance with the customary short rate table and procedure. If the company cancels, earned premium shall be computed pro rata. Premium adjustment may be made either at the time cancellation is effected or as soon as practicable after cancellation becomes effective, but payment or tender of unearned premium is not a condition of cancellation.

19. Declarations — By acceptance of this policy the named insured agrees that such statements in the declarations as are made by him are his agreements and representations, that this policy is issued in reliance upon the truth of such representations and that this policy embodies all agreements existing between himself and the company or any of its agents relating to this insurance.

IN WITNESS WHEREOF, the _____ Indemnity Company has caused this policy to be signed by its president and a secretary at _____ and countersigned on the declarations page by a duly authorized agent of the company.

(FACSIMILE OF SIGNATURE) (FACSIMILE OF SIGNATURE)

_____ Secretary

_____ President

B GEOTECHNICAL

PHASE II GENERAL DESIGN MEMORANDUM

GEOTECHNICAL APPENDIX

OAK STREET DRAIN
FLOOD CONTROL PROJECT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

No.

FIGURES

No.

PLATES

No.

PLATES (Continued)

No.

PHASE II GENERAL DESIGN MEMORANDUM
GEOTECHNICAL APPENDIX
OAK STREET DRAIN
FLOOD CONTROL PROJECT

INTRODUCTION

1. Purpose and Scope. Geologic and soils investigations were conducted to determine the foundation and groundwater conditions, and soils design values along the alignment of the proposed flood control improvements. An evaluation was also made of the sources and quality of construction materials. This appendix provides the geotechnical design criteria and construction considerations for the planned structures.

2. Project Features. Improvements to Oak Street Drain will provide flood protection for the entire reach extending from the Oak Street Debris Basin to its confluence with Temescal Wash. The channel improvement includes construction of a rectangular concrete channel approximately three miles long extending from the debris basin to 386 feet downstream of the Santa Fe Railroad. (See pls. 3 through 16 in the main report of this volume.) As the concrete channel approaches Linclon Avenue, the open rectangular section transitions to a covered reinforced concrete box culvert and passes under the Riverside Freeway. Downstream of the freeway, the box transitions back to an open rectangular section. Four hundred eight-six feet downstream of the Santa Fe Railroad, the concrete channel ends and an energy dissipator begins. The energy dissipator will consist of a trapezoidal cut channel and levees, with the slope and invert covered with grouted stone from stations 36+00 to 31+00. Downstream of station 31+00 the slope and invert will be protected with 15 inches of grouted stone. The covered box culvert passing under the Riverside Freeway will require special construction methods consisting of tunnel jacking. New construction of a bridge for the Santa Fe Railroad will be required to accommodate channel improvements.

GEOLOGY

3. Topography and Geology. The project is located on Recent and older alluvial fan deposits at the base of the Santa Ana Mountains in the City of Corona. These fan deposits consist of varying percentages of silt, sand, gravel and cobbles. Below Oak Street Debris Basin which was constructed in 1978 by Riverside County, the topography slopes uniformly toward the north with a gradient which varies from 120 to 150 feet per mile. The topography at the debris basin is more complex due to the effects of the Chino and Elsinore Fault System.

4. Faulting and Seismicity. The Chino fault and the Elsinore fault zone occur near Oak Street Drain. The closest branch of the Elsinore fault zone, the Main Street fault, occurs approximately 500 feet southwest of Oak Street Debris Basin. The location of the Chino fault can only be inferred because it is concealed by alluvium. If the Chino fault is extended along topographic features projecting from mapped exposures in the Chino Hills, the Chino fault crosses Oak Street Drain approximately 650 feet downstream of the debris basin.

In the vicinity of Oak Street Drain, the Elsinore fault zone exists as a 3/4-mile-wide zone composed of several named branches along with numerous minor faults. The Elsinore fault zone separates the early Mesozoic rocks which make up the bulk of the Santa Ana Mountains from a strip of exposed Cretaceous and Tertiary sediments at the base of the mountains. A 1972 study by Langenkamp and Combs of the microseismicity of the Elsinore fault zone led the researchers to the conclusion that: (1) the micro-earthquake activity is least in the vicinity of Corona and increases to the south; (2) the Elsinore fault is not tectonically as active as the San Andreas or San Jacinto faults; and (3) the first motions of events indicate a complex geometry of movement which is primarily dip-slip in contrast to strike-slip motion on the San Andreas and San Jacinto faults.

The Chino fault is considered to be a single trace which is generally covered by alluvium on its southern end. Woodward-Clyde Consultants studied the Chino fault at Prado Dam and located an offset paleosol in older alluvium which is at least 125,000 years old. Converse Davis Dixon Associates conducted limited shallow refractive seismic investigations and a shallow trench excavation across the suspected trace of the Chino fault, adjacent to the site of Oak Street Debris Basin, and did not encounter any signs of faulting.

Although both the Chino and Elsinore faults are recognized as significant Southern California faults, their degree of recent activity is questionable. Based upon topographic evidence and offset older alluvim, both faults are considered to have moved during the late Quaternary. However, there are no known instances where recent sediments in the general project area have been disrupted. Therefore, even though the maximum earthquake for either the Chino or Elsinore event, based upon fault-length criteria, exceeds magnitude 6 (if the Chino fault is considered a splay from the Elsinore fault), the probability of occurrence near the project site is low.

5. Groundwater. Groundwater levels from nearby wells (pls. 1 and 2) indicate that the historical minimum depths to groundwater, below the proposed Oak Street Drain channel invert and upstream from station 40+00, are at least 20 feet. Downstream from station 40+00, limited water well data suggests that historical groundwater levels would probably be at minimum depths ranging from 5 to 20 feet below invert, except near the confluence with the Temescal Wash channel (stations 20+00 to 17+30) where shallower depths would be expected. During the 1981 Prado Dam groundwater study conducted by the Corps of Engineers, groundwater near the downstream limit of improvement was encountered at a maximum elevation of approximately 556 feet, or about 1 foot above the proposed channel invert at station 17+30. The study concluded that water levels in the Corona area were among the highest recorded within the past 50 years. A 40-foot minimum depth to groundwater and localized zones of perched water at a depth of 36 feet were encountered during explorations at the debris basin in 1978. The regional water table was not encountered during subsurface investigations performed by the Corps of Engineers along the channel alignment, except in test trench TT83-2 at station 29+00. Groundwater was present at a depth of 12.5 feet (approximate elevation, 556 feet) or about 7 feet below the proposed channel invert. Depths to water of 3 feet in nearby test trenches TT83-1 and TT83-3 reflected surface flows in Temescal Wash and Oak Street Drain.

Groundwater-related problems are not anticipated to occur during construction of the Oak Street Drain channel upstream from station 20+00. However, downstream from station 20+00, shallow groundwater occurring during periods of high rainfall may exceed the elevation of the proposed channel invert. Diversion and control of surface flows along the channel alignment may also be necessary during periods of high rainfall.

CHANNEL INVESTIGATION

6. Corps of Engineers Exploration and Sampling. Exploration for the proposed channel improvements consisted of excavating eighteen test trenches, drilling two test holes, and obtaining two representative test samples. The test trenches were excavated during November 1979 and September 1983 to an average depth of 14 feet. The test holes were drilled in 1984 at the Santa Fe Railroad Bridge to an average depth of 41 feet. The test samples of representative borrow materials, identified as TS 84-1 and TS 84-2, were obtained by hand shovel. The materials encountered were visually classified and disturbed samples of representative materials were obtained for laboratory classification. The test trench, test hole, and test sample locations are shown on plates 3 through 16.

7. Supplemental Exploration. Channel foundation investigations for the Sixth and Tenth Street Bridges were conducted by Converse Davis Dixon Geotechnical Consultants during March 1978 under contract to the City of Corona. The location of these borings, identified as Boring Nos. 1, 2, 3, 4, and 5, are shown on plates 10 and 11. CALTRANS Logs of Test Borings, identified as B-1 and B-2, were drilled in 1958 near the channel undercrossing at the Riverside Freeway. The locations of B-1 and B-2 are shown on plates 12 and 13. The logs for all supplemental exploration are shown on plate 19.

FOUNDATION CONDITIONS

8. Channel. The logs of exploration indicate that the foundation materials along the channel alignment consist predominantly of silty sands, gravelly sands, and silty sandy gravels. There are a few occurrences of medium stiff to stiff sandy silts and sandy clays which range in thickness from 1 to 3 feet. The cohesionless foundation materials are medium dense to very dense with dry to moist conditions. Groundwater was encountered in the downstream reach at approximately station 30+00 near the confluence with Temescal Wash.

9. Santa Fe Railroad Bridge. The subsurface materials at the Santa Fe Railroad Bridge consist primarily of medium dense to dense gravelly sands and silty gravelly sands. Two layers of silty gravelly sand at depths of 19 and 25 feet are medium dense as indicated by adjusted SPT blowcounts of 19 and 11, respectively. A layer of very stiff sandy silt, with an adjusted SPT blowcount of 17 and a thickness of 5 feet, was encountered at a depth of 23 feet. Groundwater was not encountered and, therefore, was not a factor in the design of the bridge foundation.

10. Riverside Freeway. The logs indicate that the materials beneath the Riverside Freeway range from silty sands to silty sandy gravels and are in a loose to dense condition. The percentage of fines (or that portion of the sample passing the No. 200 sieve) of those materials having a silt component average 25 percent.

LABORATORY TESTING

11. Corps of Engineers Testing. Mechanical analyses, Atterberg limits, moisture content determinations, and compaction studies were conducted on representative samples from the 1979 and 1983 explorations in accordance with EM 1110-2-1906, "Laboratory Soils Testing." Direct shear tests and compaction studies were conducted on remolded samples from TS 84-1 and TS 84-2. All samples were classified in accordance with ASTM D 2487, "Classification of Soils for Engineering Purposes." The results of the laboratory classification tests are presented in the logs of exploration on plates 17 and 18. The results of laboratory tests performed on samples TS 84-1 and TS 84-2 are presented in figures 1 through 5.

12. Supplemental Testing. Laboratory testing performed by Converse Davis Dixon Geotechnical Consultants for the Sixth and Tenth Street Bridge investigations consisted of field unit weight and moisture content determinations, consolidation tests, direct shear tests, compaction studies, sand equivalent tests, and chemical tests. The results of field unit weight and moisture content determinations are presented in the logs on plate 19.

ANALYSIS OF DATA

13. Soils Design Values. The design values for the soils existing along the channel alignment are based upon interpretation of the Corps of Engineers and supplemental laboratory test results, and the criteria given in EM 1110-2-1913, "Design and Construction of Levees." The selected soils design values are given in table 1 below.

Table 1. SOILS DESIGN VALUES.

Properties	Compacted Fill or Backfill	In-situ Foundation Material
Dry Weight (pcf)	119	114
Moist Weight (pcf)	130	124
Saturated Weight (pcf)	137	131
Direct Shear; Angle of Internal Friction, Ø (degrees)	38	35
Cohesion, c (psf)	0	0
Permeability (fpd)	1.0	1.0

14. Borrow Areas. Approximately 41,000 cubic yards of material will be required for construction of the channel levees beginning 600 feet downstream of the Santa Fe Railroad. Fill for the levees may be obtained from the required channel excavations immediately adjacent to and upstream of the proposed levees. Adequate quantities of acceptable materials, also produced from the required channel excavations, are available for use as backfill behind channel walls.

CONCRETE CHANNEL DESIGN AND CONSTRUCTION CONSIDERATIONS

15. Concrete Channel Design Loads. The equivalent fluid pressure acting on vertical channel walls is 33 pcf if sufficient yield of the channel walls is permitted to obtain active loading conditions. The recommended maximum allowable bearing pressure for channel structures is limited to 4000 pounds per square foot. The maximum allowable bearing pressure is based on the total of dead plus frequently applied live loads. If normal code requirements are used for seismic design, this bearing pressure may be increased by 33 percent for short durations of seismic loading.

16. Excavation. The use of conventional equipment and procedures will be adequate for concrete channel excavation. Dewatering operations will not be necessary for constructing the majority of the concrete channel; downstream from station 20+00 may require dewatering depending on the season. Diversion and control of surface water may be necessary during periods of high rainfall to construct the channel. All vertical cuts with a height greater than 5 feet should be adequately braced. The allowable slopes for temporary excavation cuts with heights between 5 and 20 feet should be no steeper than 1V on 0.75H. Exposed slope surfaces should be kept moist (but not saturated) during construction to minimize local sloughing. No surcharge loads should be allowed within 5 feet of the top of a temporary slope cut.

17. Subgrade Preparation. Considering the medium dense to dense and medium to stiff characteristics of the natural soils, the channel invert slab, continuous channel wall footings, and channel wall backfill may be placed directly on the exposed natural soils.

18. Compacted Backfill. Material for compacted backfill behind channel walls will be selected from the required excavations. Cobbles larger than 4 inches will not be used as backfill. The backfill materials shall be moistened to near optimum moisture content, placed in loose lifts not exceeding 8 inches, and compacted to at least 90 percent of maximum density as determined by ASTM D 1557, "Moisture-Density Relations of Soils and Soil Aggregate Mixture Using 5.5-pound Rammer and 18-inch Drop."

19. Subdrainage System. A subdrainage system will be required from stations 20+00 to 17+30 to prevent excessive uplift pressure due to potential high groundwater conditions. The subdrainage system will consist of a 6-inch perforated pipe placed within a 6-inch layer of gravel. The 6-inch perforated pipe will be located along the centerline of the rectangular channel and will drain into the invert at the downstream end of the rectangular concrete channel. A cover of at least 6 inches of drain material will be provided around the perforated pipe. The recommended drain material is a 3/8-inch concrete aggregate with a gradation similar to that shown in table 3.

For this gradation of drain material, the drain pipe perforations will have a diameter no larger than 1/4 inch. See plate 16 of the main report of this volume for a typical detail.

LEVEE AND TRAPEZOIDAL CUT ANALYSIS

20. Design Values. All levee fill material will be obtained from selected borrow areas within the required channel excavations. The engineering properties of these materials used in-situ and as compacted fill are given in table 1 of paragraph 13 above. The levee fill material will be compacted to 90 percent of maximum density (ASTM D 1557).

21. Seepage Analysis. Because the possible duration of levee submergence during design flood conditions is short (approximately 6 hours) and the levee materials have a low to medium permeability, it was determined that steady state seepage would not develop. Therefore, the stability of the landside slope under steady seepage conditions was not analyzed.

22. Slope Stability Analysis. Two representative cross sections were used in the slope stability analysis. These two cross-sections, at stations 32+00 and 23+00, represent cut and fill portions respectively, of the trapezoidal channel, where the levee reaches its maximum height. The stability of the channel slopes was analyzed in general accordance with EM 1110-2-1902, "Stability of Earth and Rockfill Dams." Computer-aided solutions were obtained using the UTEXAS2 program, I0029C. The riverside slope was analyzed for rapid drawdown, earthquake loading and long-term static loading conditions. The earthquake analysis was conducted utilizing pseudo-static methods with a seismic coefficient of 0.15.

23. Results of Stability Analysis. For the soils design values given in table 1, and the selected riverside slopes of 1V on 2H, the factors of safety are as follows:

	Rapid Drawdown	Earthquake Loading	Long-term Static Loading
Sta. 32+00 Riverside Slope	1.04	1.1	1.5
Sta. 23+00 Riverside Slope	1.4	1.2	1.7

The landside slope of 1V on 2H has factors of safety of 1.1 and 1.6 for earthquake loading and long-term static loading, respectively.

TRAPEZOIDAL CHANNEL DESIGN AND CONSTRUCTION CONSIDERATIONS

24. Excavation and Foundation Treatment. The use of conventional equipment and procedures will be adequate for levee and trapezoidal channel excavation. Some dewatering operations may be required, depending on the season, for the riprap channel structures downstream of station 35+00. All existing levee fill, which ranges in height from 2 to 10 feet and is in a loose condition, will be removed to the natural subgrade. This material may be stockpiled for use as borrow material. The levee foundations will be cleared, grubbed and stripped to a depth of 12 inches and to a width of at least 5 feet outside of the levee toes. The foundation will be restored to grade with suitable material obtained from selected borrow areas (paragraph 14) and placed in 12-inch loose lifts and compacted to at least 90 percent of maximum density (ASTM D 1557). Prior to the placement of the first lift of fill, the surface will be scarified to a minimum depth of 4 inches, moistened to near optimum moisture content, and compacted with 4 passes of the compaction equipment.

25. Trapezoidal Channel. The riverside and landside slopes of the trapezoidal channel will be 1V on 2H. The levee embankment of the trapezoidal channel will be composed of fill material obtained from the borrow areas (paragraph 14) and compacted to at least 90 percent of maximum density (ASTM D 1557). The levee fill will be placed in loose lifts not exceeding 12 inches in thickness. Any stone larger than 9 inches will be raked to the outer portion of the embankment slopes or used in the toe backfill. Stones larger than 12 inches will not be used in embankment fill.

26. Slope Protection. The riverside slope and invert of the trapezoidal channel will be protected with a 15-inch and 36-inch layer of grouted stone respectively between stations 31+00 and 36+00. Between stations 20+00 and 31+00, the slope and invert will be protected with a 12-inch layer of stone. Between stations 17+30 and 20+00, the slope and invert will be protected with reinforced concrete, respectively. The specific gravity of all stone used shall not be less than 2.60. The stone gradations are given below.

15-inch Stone

Weight of Individual Pieces (pounds)	Approximate Average Dimension (inches)	Percent Smaller by Weight
250	15	100
100	11	50-95
50	9	20-50
20	7	0-15

24-inch Grouted Stone

Weight of Individual Pieces (pounds)	Approximate Average Dimension (inches)	Percent Smaller by Weight
2000	32	100
1000	24	65-100
700	21	50-70
400	18	15-50
150	13	0-15

To prevent erosion of the underlying soil, a layer of bedding material will be required beneath the ungrouted stone layers. The bedding material will consist of a 9-inch layer of cobbles and gravel with the following gradation.

Bedding Material

Sieve Size	Percent Finer by Weight
5-inch	100
3-inch	50-90
1-inch	20-50
3/8 inch	0-15

27. Sources of Stone. Several quarries which have produced stone acceptable for use on other Corps of Engineers projects are located within 5 miles of the project site (see table 2). At least three active quarries are located in Temescal Canyon. Another is on the east edge of the City of Corona. Additional quarries are producing stone from the Jurupa Mountains and are located 12 to 14 highway miles from the project. Both the Stringfellow and Declesville quarries were used in 1983 at Morro Bay. The Slover Mountain quarry, located 23 highway miles from the project, is another possible source of rock. Based upon laboratory test results, marble, gneiss and diorite from this quarry were approved for use on the Los Angeles Harbor breakwater repair in 1983; however, the rock was not used. Although all the quarries listed in table 2 have produced acceptable rock in the past, it cannot be assumed that all rock produced from these quarries has been or will be acceptable. These sources may also provide bedding material.

FLEXIBLE PAVEMENT DESIGN FOR ACCESS ROADS

28. Design Values. As the logs of exploration indicate, the foundation materials along the channel alignment consist predominantly of silty sands, gravelly sands, and silty sandy gravels with a few occurrences of sandy silt and sandy clay layers ranging in thickness from 1 to 3 feet. During excavation, filling, and backfilling procedures for levees and behind channel walls, the few silt and clay materials will be blended with the coarser sand and gravel materials resulting in a generally non-cohesive pavement subgrade.

Accordingly, conservative CBR values of 10 and 15 are selected for subgrade soils compacted to 90 and 95 percent, respectively, of the maximum density determined by ASTM D 1557. The minimum CBR value of base course materials compacted to 100 percent of maximum density will be 80.

29. Design Criteria. The flexible pavement forming the access roads behind channel walls and on levees was designed in accordance with TM 5-822-5, "Flexible Pavements for Roads, Streets, Walks, and Open Storage Areas." A Class F, single lane road will allow 60 vehicles per day, of which 90 percent are passenger cars and light pickup trucks (Group 1 vehicles) and 10 percent may be buses and two-axle trucks (Group 2 vehicles). A traffic composition of Category II will allow 90 percent Group 1 vehicles and 10 percent Group 2 vehicles. The Design Index for a Class F road with Category II traffic is 1. These design criteria will be more than satisfactory for the anticipated traffic on the access roads.

30. Pavement Section. Pavement sections should be sloped in a manner to facilitate surface drainage. The following pavement section is selected to satisfy the traffic design criteria and CBR, minimum thickness, and depth of compaction requirements:

ACCESS ROADS

Thickness (inches)	Materials
2	Asphaltic Concrete
--	Prime Coat
4	Stabilized Aggregate Base Course compacted to 100%
6	Levee Fill or Channel Wall Backfill compacted to 95%

Table 2. SOURCES OF ST

Quarry and Location	Distance to Project (miles)	Rock Type	Specific Gravity Bulk SSD	Absorption	Density (pcf)
Declesville 1S/6W Sec 35	14	Granite	2.72-2.80	0.1-0.44	169.7-174.7
Stringfellow 2S/6W Sec 35	12	Granite	2.60-2.71	0.1-3.2	162.2-169.1
Magnolia 3S/6W Sec 30	3	Granite	2.60-2.65	0.16-0.33	162.2-165.4
3M 4S/6W Sec 4	6	Volc.	2.67-2.69	0.2-0.5	166.6-167.9
Corona Rock 3S/6W Sec 33	5	Granite	2.72	0.09	169.7
Corona Pacific 3S/6W Sec 33	5	Granite	2.69	0.03	167.9
Slover Mountain 1S/4W Sec 19	23	Gneiss and Diorite	2.73-2.95	0.1-0.3	170.4-184.1
Slover Mountain 1S/4W Sec 19	23	Marble	2.7-3.04	0.1-0.3	168.5-189.7

Table 2. SOURCES OF STONE.

tion	Density (pcf)	L.A. Abrasion (%)	Date Last Tested	Remarks
-0.44	169.7-174.7	25-47	Nov 83	Placed in L.A. Harbor Breakwater in 1903; No Deterioration. Used at Morro Bay 1983.
-3.2	162.2-169.1	10-34	Jul 66	Used at Morro Bay 1983.
5-0.33	162.2-165.4	12-16	Aug 70	Used at Redondo Groin.
2-0.5	166.6-167.9	10	Sep 83	Used at Morro Bay & Dana Point.
.09	169.7	13.5	Nov 72	
.03	167.9	13.2	Nov 72	Used for Newport Groin and Dana Point.
1-0.3	170.4-184.1	43.7	Nov 83	
.1-0.3	168.5-189.7	31.1-38.0	Nov 83	

SANTA FE RAILROAD BRIDGE FOUNDATION DESIGN

31. Foundation Design. The results of the field investigations and laboratory tests indicate that spread footings founded on the dense or stiff natural soils will provide adequate support for the railroad bridge. Footings should be founded at least 24 inches below the channel invert.

The recommended maximum allowable bearing pressure for the railroad bridge foundation is limited to 6000 pounds per square foot. The maximum allowable bearing pressure is based on the total of dead plus frequently applied live loads. If normal code requirements are used for seismic design, this bearing pressure may be increased by 33 percent for short durations of seismic loading.

Settlements of the proposed railroad bridge structure, supported as recommended, should be within acceptable limits. When the structural loads are known, Soils Design Section should be contacted to calculate anticipated settlements, and confirm that the settlements are within tolerable limits.

RIVERSIDE FREEWAY UNDERCROSSING

32. Jacked Box Conduit. The subgrade materials beneath the Riverside Freeway range from silty sands to silty gravelly sands; stabilization by chemical grouting and tunneling of these materials is not feasible because of their substantial silt content. The minimum cover available for the reinforced concrete (R.C.) box conduit is 9.0 feet at the upstream end of the undercrossing increasing to 11.7 feet at the downstream end. Therefore, it is recommended that the R.C. box conduit be jacked in place by a qualified jacking contractor. Consideration should also be given to jacking two smaller single-box conduits side by side instead of the one large box conduit.

33. Recommended Conduit Loads. The loads to be used for the structural design of the R.C. conduit are presented below. These loads should be verified by the Technical Specialists Group (SPLED-DT), and Soils Design Section should be consulted if the design loads are changed. The design loads are based upon a minimum cover of 9.0 feet, AASHTO HS20-44 loading, and a R.C. box conduit with a height of 11.0 feet and width of 24.0 feet. The dead and live loads are:

a. Vertical Soil Dead Loads (Top of Slab):	
Upstream end of conduit	1100 psf
Downstream end of conduit	1400 psf
b. Lateral Soil Dead Load:	
Equivalent fluid pressure (At-rest earth pressure)	50 pcf
c. Highway Live Loads:	
Top of slab	100 psf
Invert	75 psf
Lateral	45 psf

CONCRETE MATERIALS

34. Purpose and Scope. This portion of the appendix is prepared in compliance with ER 1110-2-1150, 4 October 1972 (Change 3) and in conformance to the requirements of EM 1110-2-2000, dated 30 September 1982. The results of field investigations covering proposed material sources for the concrete structures required for construction of Oak Street Drain are presented. A general description of aggregate and other concrete materials sources is given in addition to a dicussion and summary of the investigation and concrete requirements.

35. Concrete Investigations.

35.1 Climatic Conditions. Elevation, topography, and distance from the ocean influence the climate of the Santa Ana River Basin. The lower elevations of the basin have a semi-arid, subtropical climate. Summer climates are long, hot and dry, and temperatures often exceed 90°F.; winters are short, cool and mild, with only infrequent frost in urbanized areas of the basin.

Annual precipitation averages 12 to 16 inches per year in the upper valley and coastal plain. About 90 percent of this rainfall occurs between November and April; there is practically no rainfall in summer months. Summer thundershowers occur in the mountains, but do not contribute significantly to runoff. The average annual precipitation in the mountainous areas of the watershed exceeds 45 inches in some places; above the elevation of 6000 feet, precipitation usually occurs as snow in the winter months.

35.2 Concrete Quantities Required. It is estimated that 24,900 cubic yards of concrete will be required for construction of Oak Street Drain. All concrete placed for the channel will have a 28-day compressive strength of 3000 pounds per square inch (psi). The following tabulation lists required concrete quantities for the various structures.

Required Concrete Quantities

Structure	Quantity (cubic yards)
Channel Invert	14,600
Channel Walls	10,300

The maximum size aggregates will be 1-1/2 inches for the channel invert, and 3/4-inch for vertical walls, or otherwise when conditions exist as stipulated in the contract specifications.

35.3 Grouted Stone. Approximately 600 lineal feet of grouted stone will be required in the project design. Cement and sand to be used in the grout can be supplied by the approved sources. The estimated cement content per cubic yard of grout is 7-1/2 sacks, with a water content in the mix not to exceed 8-1/2 gallons per sack of cement. Moist curing will consist of covering the grout with a uniform thickness of sand kept continuously saturated for a period of 14 days, or using an approved curing compound.

35.4 Basis for Design of Concrete Mixes. The design of the concrete mixes is based on a 28-day compressive strength and a required water-cement ratio to satisfy durability requirements. In meeting the required water-cement ratio, the resulting strength is likely to be higher than the required design or control strength. The 28-day compressive strength for concrete box culvert sections would be 4000 psi, and 3000 psi for all other structures. The maximum water-cement ratio, by weight, would be 0.45.

36. Cementitious Materials. The approved sources of cementitious materials available for use in the project area are shown on plate 20. The primary sources used by local concrete suppliers are California Portland Cement Company at Colton, and Riverside Portland Cement Company at Crestmore. Type II, low alkali cement will be specified and is commonly used in the project area.

37. Aggregate Investigation.

37.1 The Waterways Experiment Station Technical Memorandum No. 6-370, September 1958, titled "Test Data, Concrete Aggregates in Continental United States," Volume I, Area 3, Western United States, currently lists only one aggregate source in the Oak Street Drain area (latitude 33 degrees North and longitude 117 degrees West). Additional investigations have revealed that two suitable sources are operating in the project area:

Chandler Sand and Gravel Company
24867 Maitri Road
Corona, Ca. 91720

Owl Rock Products
24000 Santa Ana Canyon Road
Anaheim, Ca. 92803

37.2 Owl Rock Products' Prado plant has been supplying concrete aggregates and ready mix concrete for a considerable length of time. Owl is currently the only aggregate producer in an area which once supplied most of the concrete material for construction in Orange County. All other sources have been depleted. Owl Rock Products' Prado plant was sampled and tested in March 1984. The results of these tests are shown in table 3.

37.3 Chandler Rock and Sand Company is a relatively new producer in the Oak Street Drain area. Located in Temescal Wash just south of Corona, Chandler is strictly a rock and sand supplier. Cursory investigation has shown that this would be a suitable aggregate source. This source was sampled in February 1985 and is being tested at the South Pacific Division Laboratory.

37.4 Ready mix plants are available near the project location with unit costs for delivered concrete from Owl Rock Products of $38.00 per cubic yard. Bulk aggregate from Chandler Sand and Gravel costs $4.05 per ton, F.O.B.

37.5 Other sources of material which have been sampled and tested and may be considered for use in the Oak Street Drain project are a considerable distance away in the San Bernardino area. These locations are shown on plate 20.

38. Results of Laboratory Tests.

38.1 Petrographic Examination. The samples obtained from Owl Rock Products consisted of coarse aggregate and fine aggregate. The coarse aggregate was a subround to subangular, generally fresh, partially crushed alluvial gravel. Individual rock types present were approximately: granitic - 45 percent; metasedimentary - 35 percent; meta-igneous - 10 percent ; and schist - 5 percent. These aggregates were hard and sound, with approximately 1.4 percent soft particles and 0.3 percent friable particles. The fine aggregate was composed of the same rock types as the coarse aggregate with individual minerals present as separate grains in the finer sieve sizes. Minerals present were quartz, feldspar, mica, horneblende and other mafic minerals.

38.2 Concrete mixture design tests have been conducted with aggregate from Owl Rock Products, cement from Kaiser and flyash from Western Ash. These mix designs have shown that 28-day compressive strengths of up to 5500 psi can by achieved with a water-cement ratio of 0.45, and that replacement of cement, by volume, with flyash of up to 20 percent can produce 28-day strengths of up to 3600 psi. A summary of physical tests conducted on aggregate from this source is shown in table 3.

Table 3. PHYSICAL TESTS ON CONCRETE AGGREGATES: OWL ROCK PRODUCTS.

Part A: Gradations in percent finer by weight

Sieve Size	1-1/2" x 3/4"	No. 4 x 1"	3/8"	Sand
2-in.	100	-	-	-
1-1/2 in.	96	100	-	-
1 in.	10	96	-	-
3/4 in.	1	61	-	-
1/2 in.		24	100	-
3/8 in.		8	99	100
No. 4		2	15	99
No. 8			3	84
No. 16				63
No. 30				38
No. 50				14
No. 100				5

Part B: Physical Tests Results

Test Requirement	1-1/2" x 3/4	#4 x 1"	3/8"	Sand
Specific Gravity ASTM C 127	2.62	2.62	2.61	2.51
Absorbation ASTM C 128	1.5%	1.4%	1.7%	3.5%
Friable Particles ASTM C 142	0.1%	0.3%	0.3%	1.1%
Soft Particles ASTM C 851	1.2%	1.4%	1.9%	-
Flat and Elongated CRD C 119	0.5%	1.0%	3.0%	-

Part C: Physical Tests on Combined Samples

Test Requirement	
Organic Impurities ASTM C 40	5.0%
Soundness of Aggregate ASTM C 88	
Coarse Aggregate	9.7%
Fine Aggregate	18.5%
Resistance to Abrasion, 500 rev., ASTM C 131	
Class (weight loss, in percent)	23%
Reactivity, Chemical Method ASTM C 289	
Fine Aggregate	Innocuous
Coarse Aggregate	Innocuous
Freeze Thaw Resistance ASTM C 666	76.5%

U.S. ARMY ENGINEER DIVISION LABORATORY -- SOUTH PACIFIC DIVISION

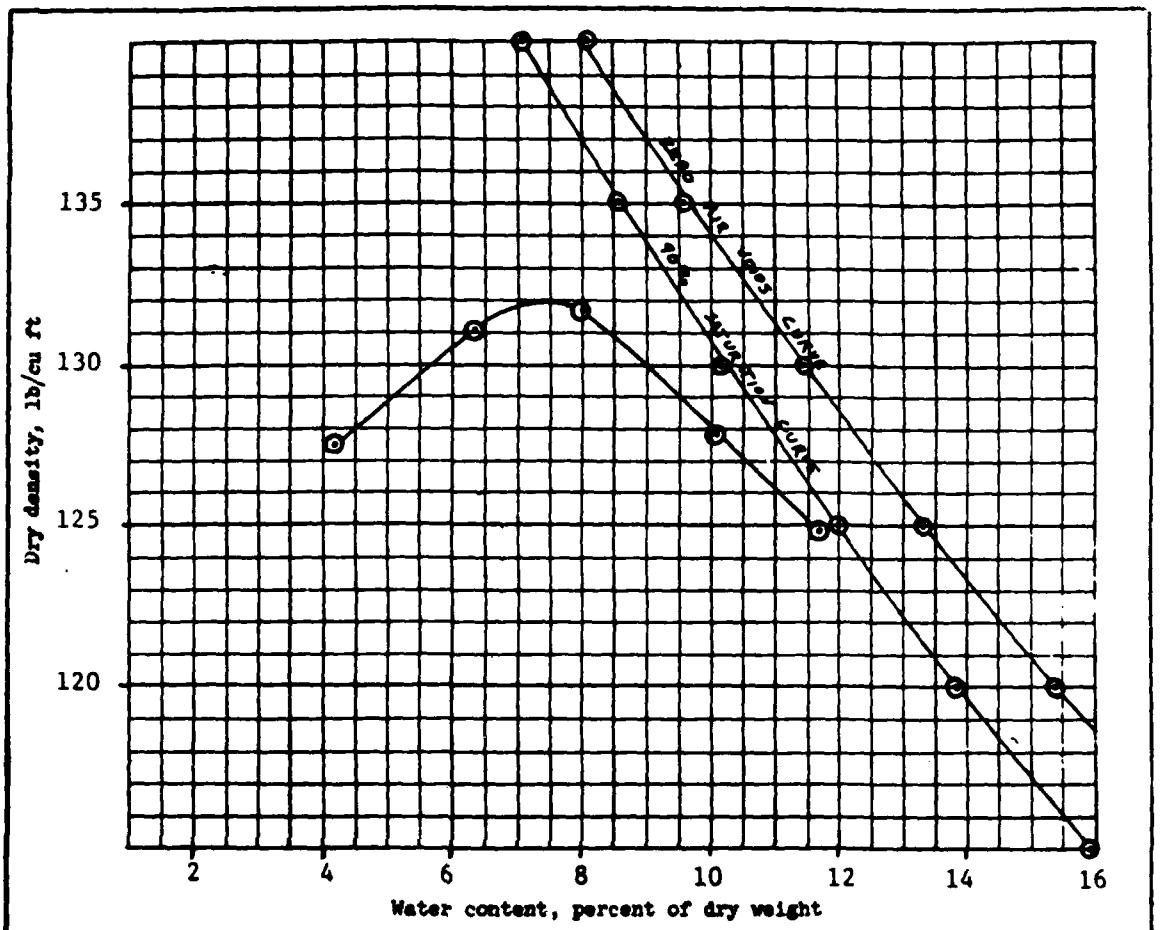
SOIL TEST RESULT SUMMARY

PROJECT OAK ST. DRAIN, SANTA ANA RIVER **DATE** October 1984

Division Serial No.	Hole No.	Field Sample No.	Depth Or Elevation From	Depth Or Elevation To	Laboratory Descriptive Classification	Mechanical Analysis-% Finer: Gravel 3/2	Gravel 1½	Gravel 3/4	Gravel 1/2	Gravel 3/8	Sand #4	Sand #10	Sand #40	Sand #60	Sand #100	Fines #200	Liquid Limit	Plasticity Index	Field Moist. %
89902	TS84-1				Silty Gravelly Sand(SP-SM)	99	98 93	89	81	76	64	50	27	19	14	9	N/P		
89903	TS84-2				Silty Gravelly Sand(SM)	98	97 92	87	79	74	61	52	31	23	17	12	19	1	

APPENDIX B FIGURE 1

SPD Form 66A



Modified compaction test

56 blows per each of 5 layers, with 10 lb rammer and

18 inch drop. 6 inch diameter mold

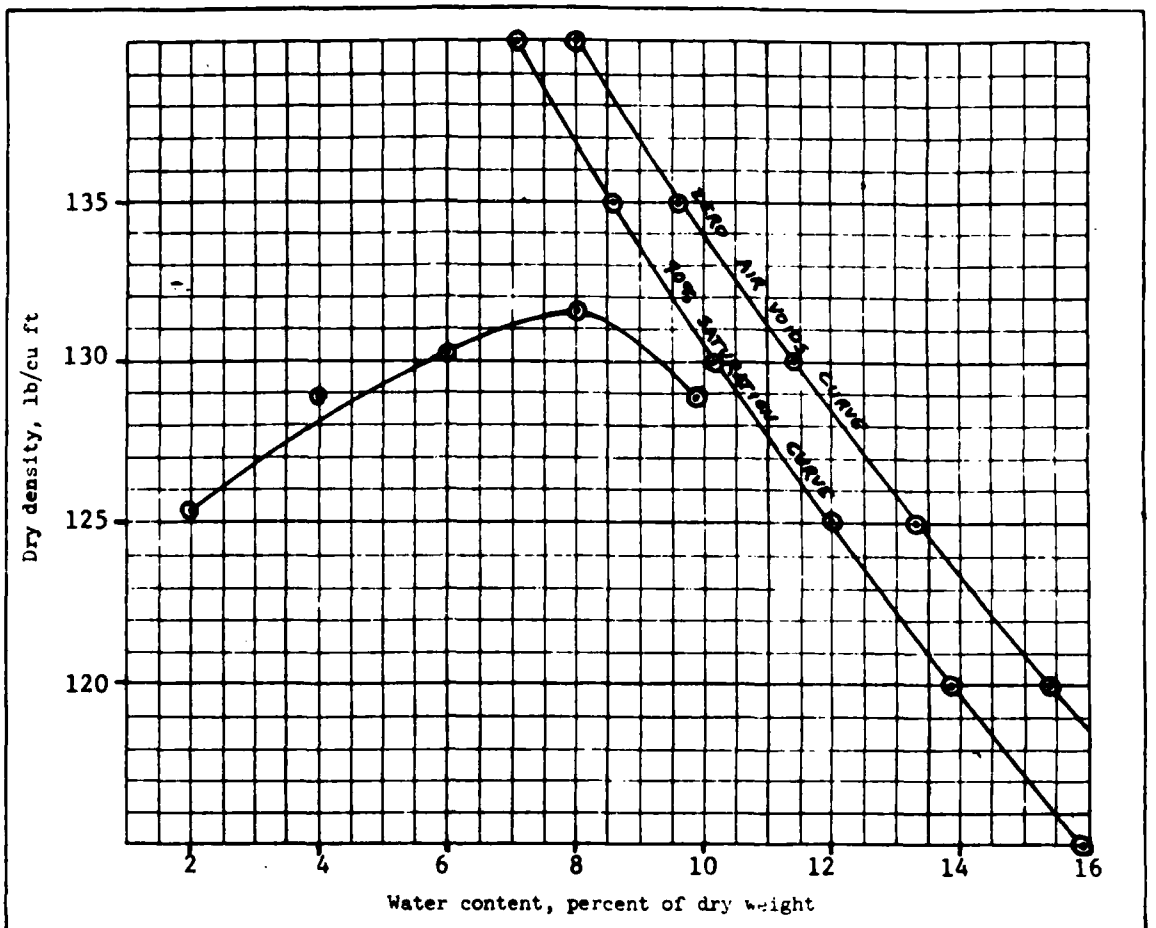
Sample No.	Elev or Depth	Classification	G	LL	PL	% > No. 4	% > 3/4 in.
89902 TS84-1		Silty Gravelly Sand (SP-SM)	2.73	NP		36	11

Sample No.	89902			
Natural water content, percent	1.3			
Optimum water content, percent	7.5			
Max dry density, lb/cu ft	131.9			

Remarks	Project OAK ST. DRAIN
	Santa Ana River
	Area
	Boring No. TS84-1 Date October 1984
	COMPACTION TEST REPORT

ENG FORM 1 JUN 65 2091 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

APPENDIX B FIGURE 2



Modified compaction test

56 blows per each of 5 layers, with 10 lb rammer and

18 inch drop. 6 inch diameter mold

Sample No.	Elev or Depth	Classification	G	LL	PL	% > No. 4	% > 3/4 in.
89903		Silty Gravelly Sand(SM)	2.73	19	1	39	13

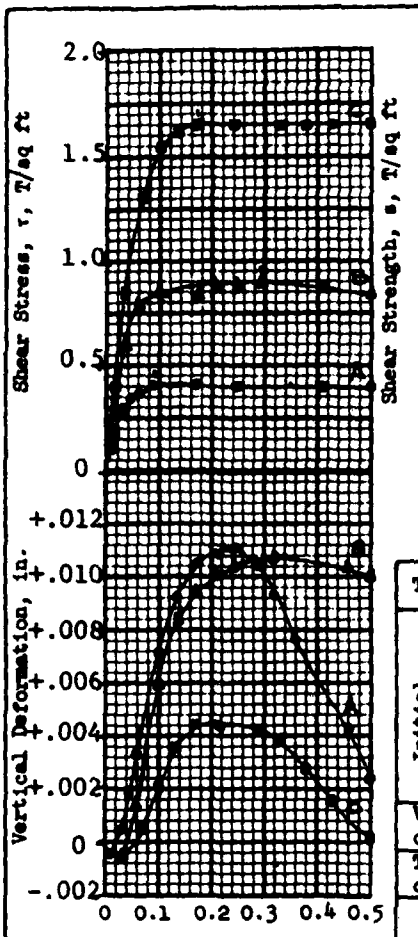
Sample No.	89903			
Natural water content, percent	1.6			
Optimum water content, percent	8.0			
Max dry density, lb/cu ft	131.4			

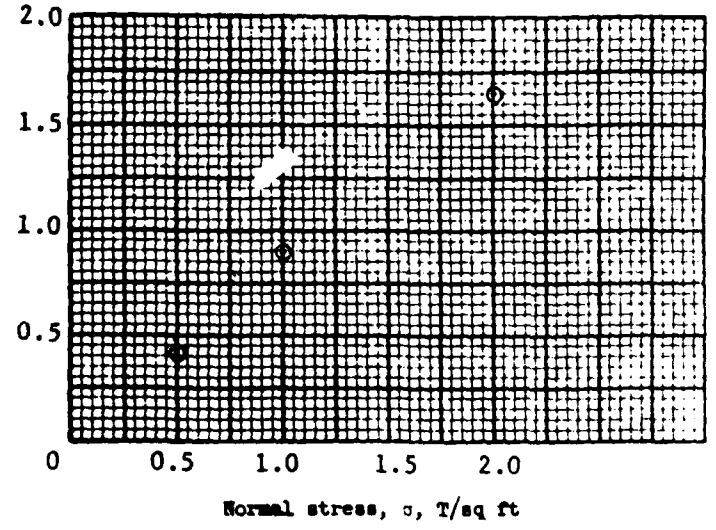
Remarks	Project OAK ST. DRAIN
	SANTA ANA RIVER
	Area
	Boring No. TS84-2 Date October 1984
	COMPACTION TEST REPORT

ENG FORM 1 JUN 65 2091 (ER 1110-2-1906) PREVIOUS EDITIONS ARE OBSOLETE

TRANSLUCENT

APPENDIX B FIGURE 3





Test No.			A	B	C	
Initial	Water content	w_o	11.3 %	11.7 %	11.5 %	%
	Void ratio	e_o	0.504	0.509	0.508	
	Saturation	S_o	61 %	63 %	62 %	%
	Dry density, lb/cu ft	γ_d	113.3	112.9	113.0	
Void ratio after consolidation		e_c	0.500	0.500	0.490	
Time for 50 percent consolidation, min		t_{50}	-	-	-	
Final	Water content	w_f	18.5 %	18.8 %	18.1 %	%
	Void ratio	e_f	0.504	0.512	0.493	
	Saturation	S_f	100 %	100%	100 %	%
Normal stress, T/sq ft		σ	0.5	1	2	
Maximum shear stress, T/sq ft		τ_{max}	0.41	0.89	1.65	
Actual time to failure, min		t_f	40	100	70	
Rate of strain, in./min			.0025	.0029	.0025	
Ultimate shear stress, T/sq ft		τ_{ult}	-	-	-	

Shear Strength Parameters

ϕ' = _____ °

tan ϕ' = _____

c' = _____ T/sq ft

☐ Controlled stress

☒ Controlled strain

Type of specimen Remolded — 3½ in. square — ½ in. thick

Classification Silty Gravelly Sand (SP-SM)

LL | PL NP | PI | | G_s 2.73

Remarks Remolded to approximately 90% maximum density @ optimum water content.

Project OAK ST. DRAIN

Area Santa Ana River

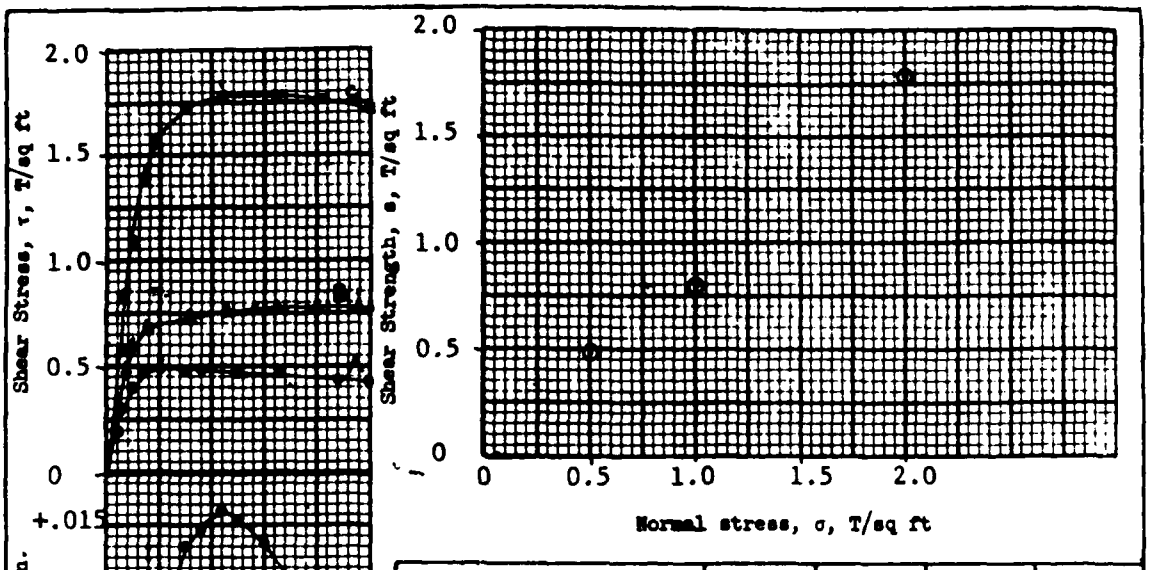
Boring No. TS 84-1 | Sample No. 89902

Depth Ft. | Date October 1984

DIRECT SHEAR TEST REPORT

ENG FORM 1 JUN 65 2092 PREVIOUS EDITIONS ARE OBSOLETE 041491

APPENDIX B FIGURE 4



Test No.			A	B	C	
Initial	Water content	w_o	11.7 %	11.8 %	11.6 %	%
	Void ratio	e_o	0.500	0.497	0.497	
	Saturation	S_o	64 %	65 %	64 %	%
	Dry density, lb/cu ft	γ_d	113.6	113.8	113.8	
Void ratio after consolidation		e_c	0.496	0.483	0.484	
Time for 50 percent consolidation, min		t_{50}	-	-	-	
Final	Water content	w_f	18.8 %	18.2 %	17.9 %	%
	Void ratio	e_f	0.513	0.497	0.489	
	Saturation	S_f	100 %	100 %	100 %	%
Normal stress, T/sq ft		σ	0.5	1.0	2.0	
Maximum shear stress, T/sq ft		τ_{max}	0.48	0.79	1.78	
Actual time to failure, min		t_f	40	180	95	
Rate of strain, in./min			.0025	0027	.0023	
Ultimate shear stress, T/sq ft		τ_{ult}	-	-	-	

Shear Strength Parameters

ϕ' = _____ °

tan ϕ' = _____

c' = _____ T/sq ft

☐ Controlled stress

☒ Controlled strain

Type of specimen: Remolded — 3½ in. square — 0.5 in. thick

Classification: Silty Gravelly SAnd (SP-SM)

LL 19 | PL 18 | PI 1 | | G_s

Remarks: Remolded to approximately 90% maximum density near optimum water content.

Project: . OAK ST. DRAIN

Area: SANTA ANA RIVER

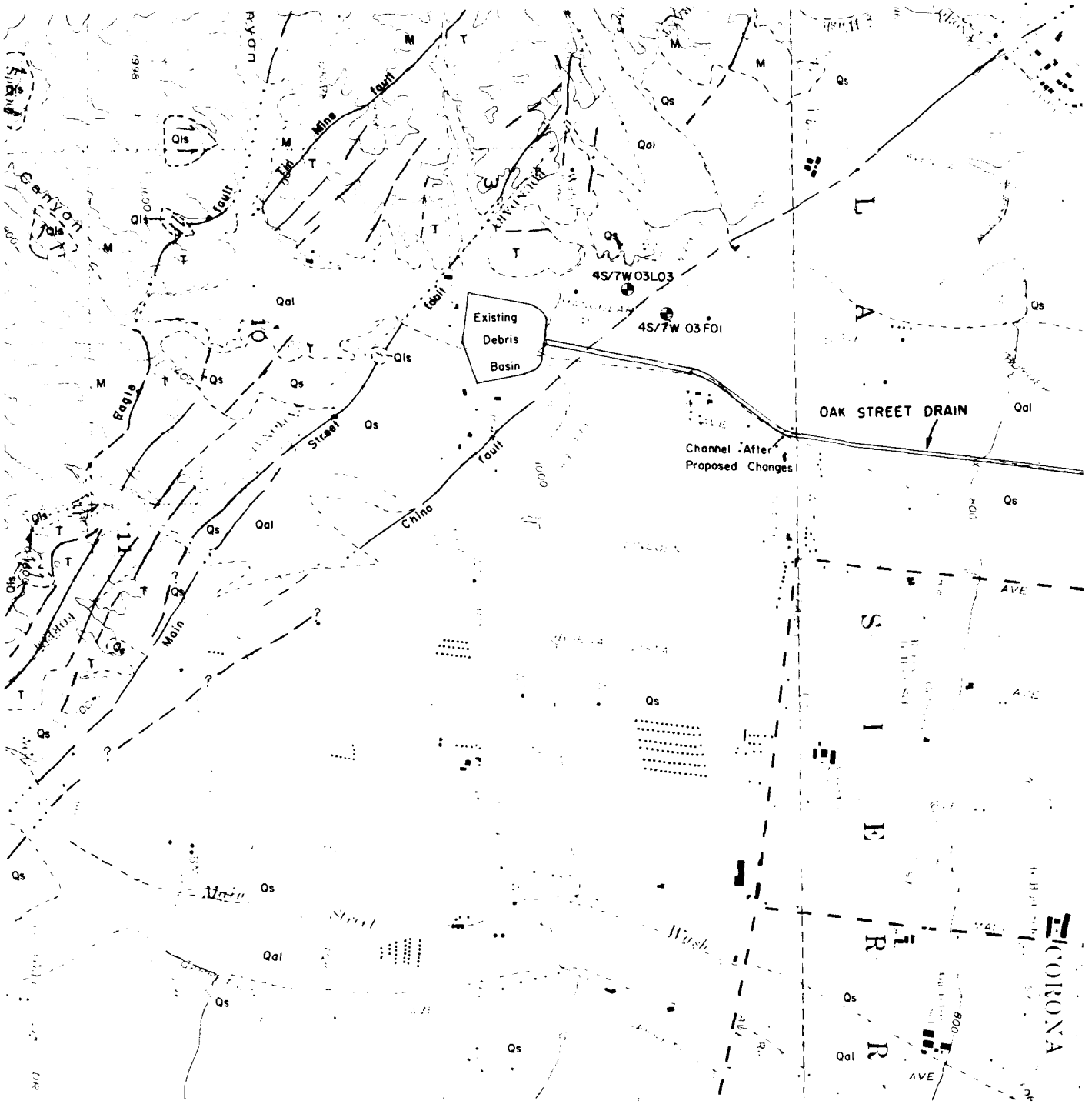
Boring No. TS 84-2 | Sample No. 89903

Depth Ft | Date October 1984

DIRECT SHEAR TEST REPORT

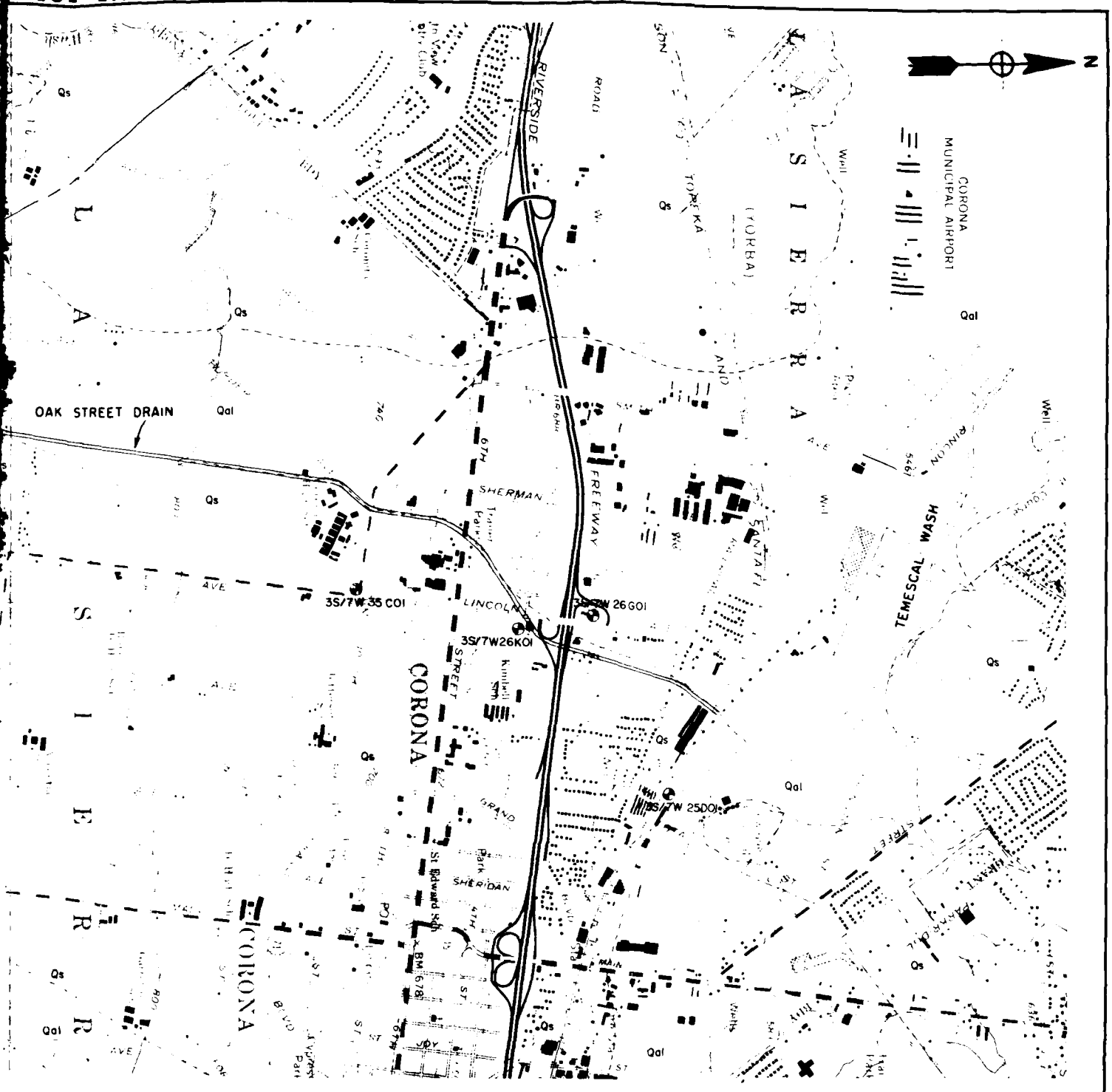
EM FORM 1 JUN 65 2092 PREVIOUS EDITIONS ARE OBSOLETE 041491

APPENDIX B **FIGURE 5**



LEGEND

Qal	Recent alluvium
Qls	Recent landslide
Qs	Pleistocene sediments
T	Tertiary sediments
M	Mesozoic rocks
	Contact; approximate location
	Fault, dashed where approximate, dotted where concealed
	Thrust fault
4S/7W 03L03	Location of water well, identified by state well number



NOTES

Geology from F Harold Weber Jr., 1977, Seismic Hazards Related to Geologic Factors, Elsinore and Chino Fault Zones, Northwestern Riverside County, California, Calif. Div. Mines and Geology, OFR 77-4.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

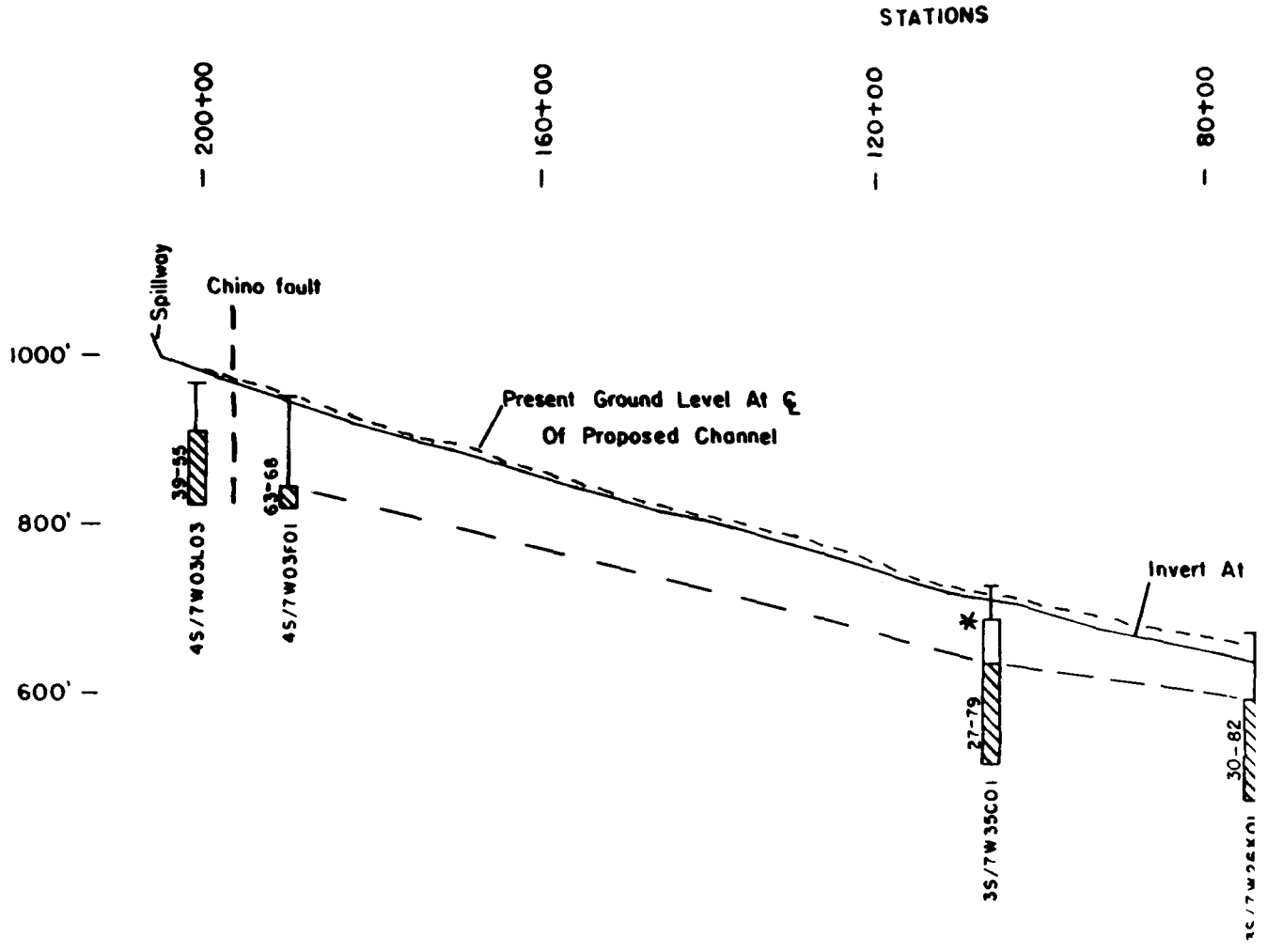
OAK STREET DRAIN
GEOLOGIC MAP

SUBMITTED BY: DATE APPROVED: CHIEF, ENGINEERING DIVISION

SPEC. NO. DACW 09-____-B-____
DISTRICT FILE NO.

SHEET

U S ARMY ENGINEER DISTRICT



EXPLANATION

Highest recorded groundwater elevation

30-55 — Years of record (1939 - 1955)

Lowest recorded groundwater elevation

* Groundwater elevation in 1924

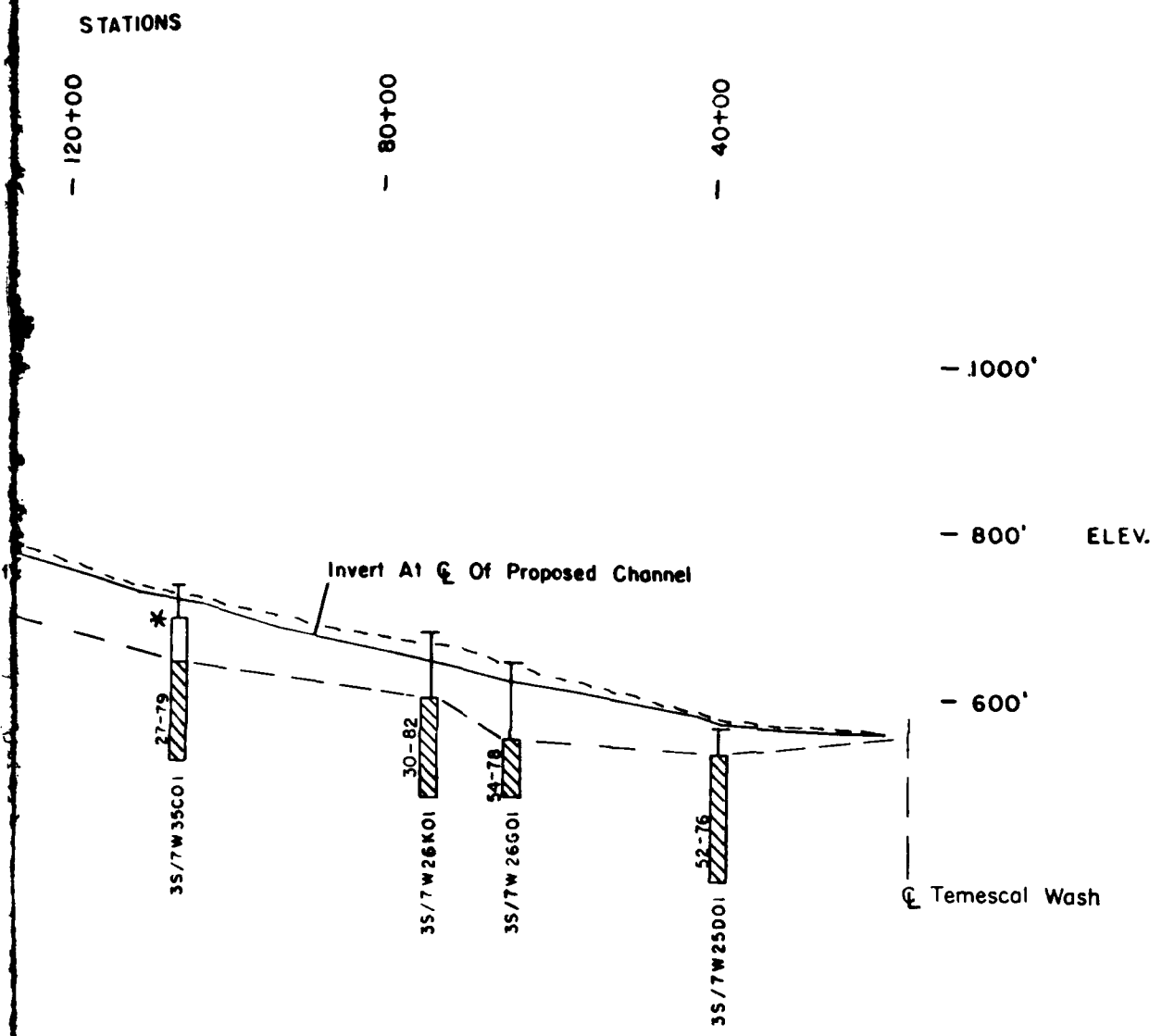
Horizontal Scale

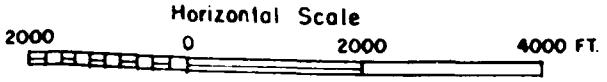
2000 0 2000

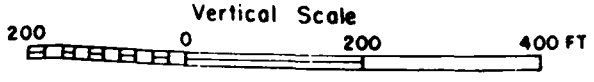
Vertical Scale

200 0 200

DATUM IS MEAN SEA LEVI







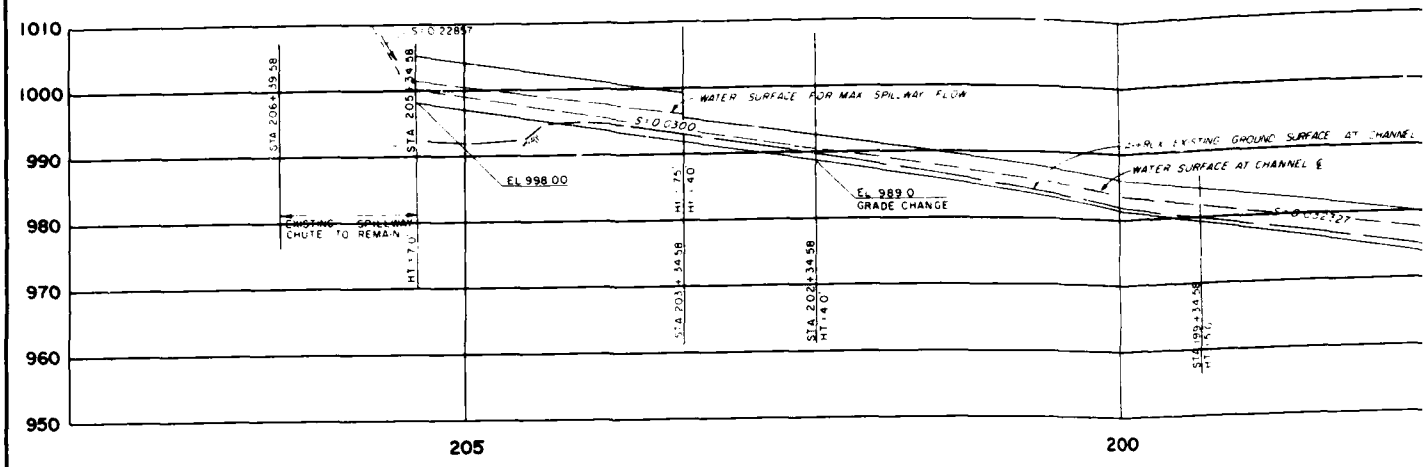
DATUM IS MEAN SEA LEVEL

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN
HYDROLOGIC PROFILE

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

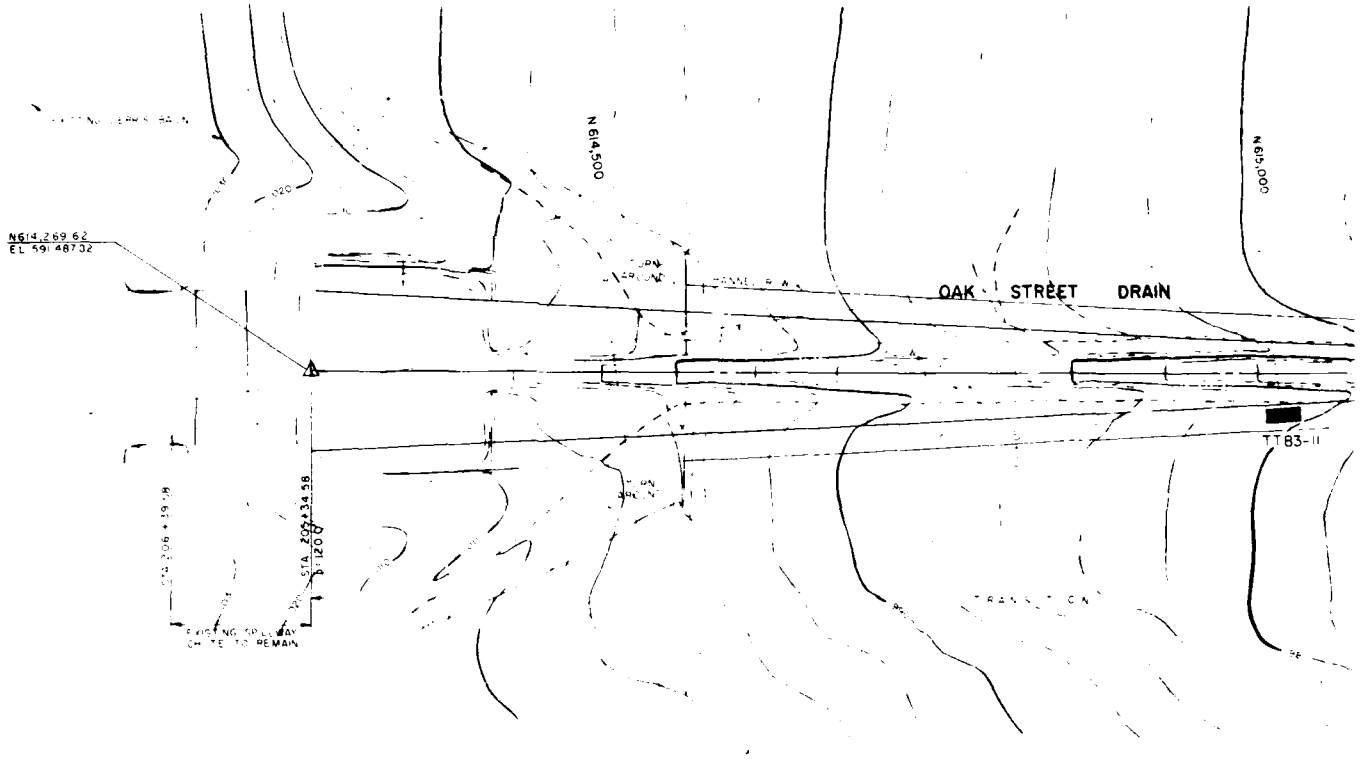
APPENDIX B PLATE 2



PROFILE

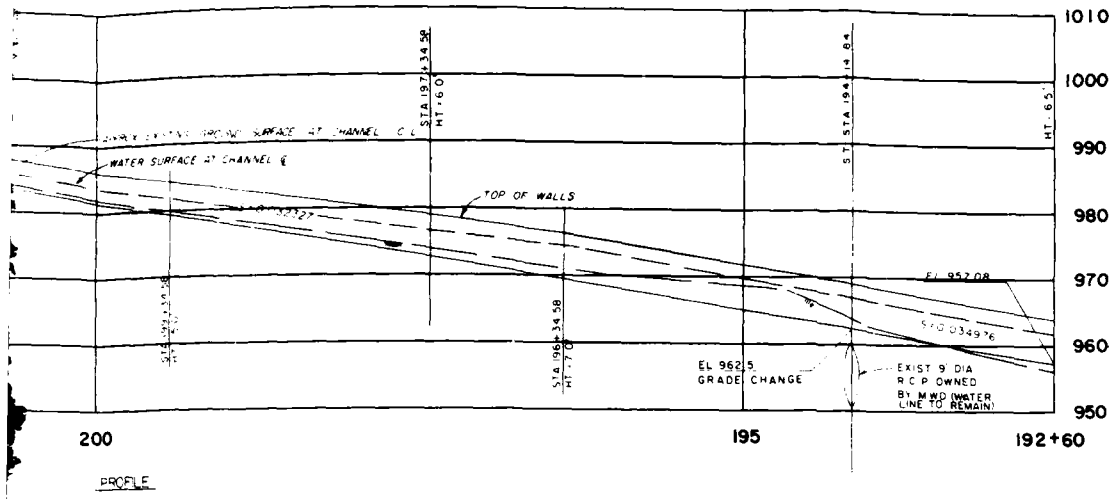
HORIZ SCALE 0 50 100 FEET

VERT SCALE 0 10 20 30 FEET



PLAN

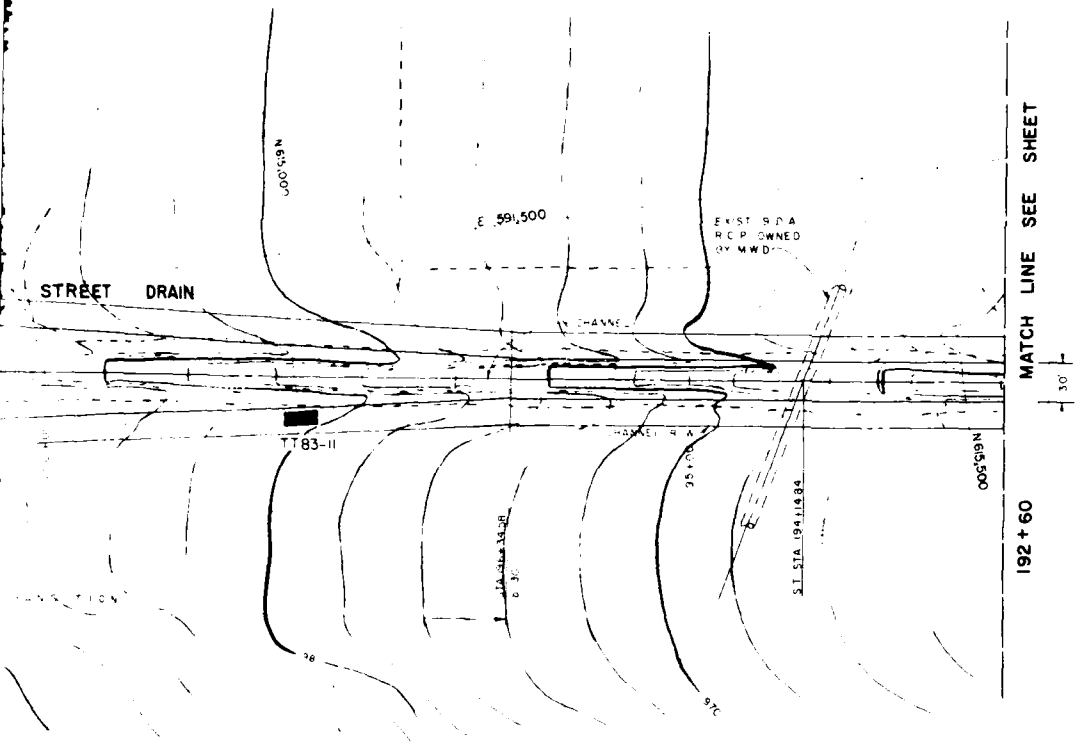
HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
206+39.58	205+34.58	120' Rect.	.22857	4,300	3.42	3.5	10.5	1.3	37.5
205+34.58	202+34.58	Trans.	.03000	4,300	Varies	1.3	37.5	2.0	27.7
202+34.58	196+34.58	Trans.	.032327	4,300	Varies	2.0	27.7	5.0	30.4
196+34.58	194+14.84	30' Rect.	.032327	4,300	8.6	5.0	30.2	4.6	33.9
194+14.84	192+60	30' Rect.	.034976	4,300	8.6	4.6	33.9	4.4	35.9



PROFILE

SCALE 50 0 50 100 FEET

SCALE 20 0 20 40 FEET



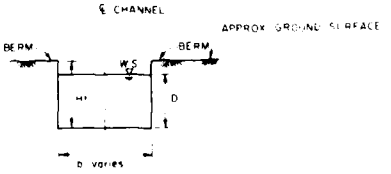
LEGEND

TT79-I	LOCATION, YEAR AND NUMBER OF TEST TRENCH U.S. ARMY CORPS OF ENGINEERS.
TS84-I	LOCATION, YEAR AND NUMBER OF TEST SAMPLE US ARMY CORPS OF ENGINEERS
TH84-I	LOCATION, YEAR AND NUMBER OF TEST HOLE U.S. ARMY CORPS OF ENGINEERS
BORING 1	LOCATION AND NUMBER OF BORING, CONVERSE DAVIS DIXON GEOTECHNICAL CONSULTANTS.
B-I	LOCATION AND NUMBER OF BORING, CALTRANS

NOTE

1. SEE PLATE 18 FOR LOGS OF EXPLORATION

PLAN



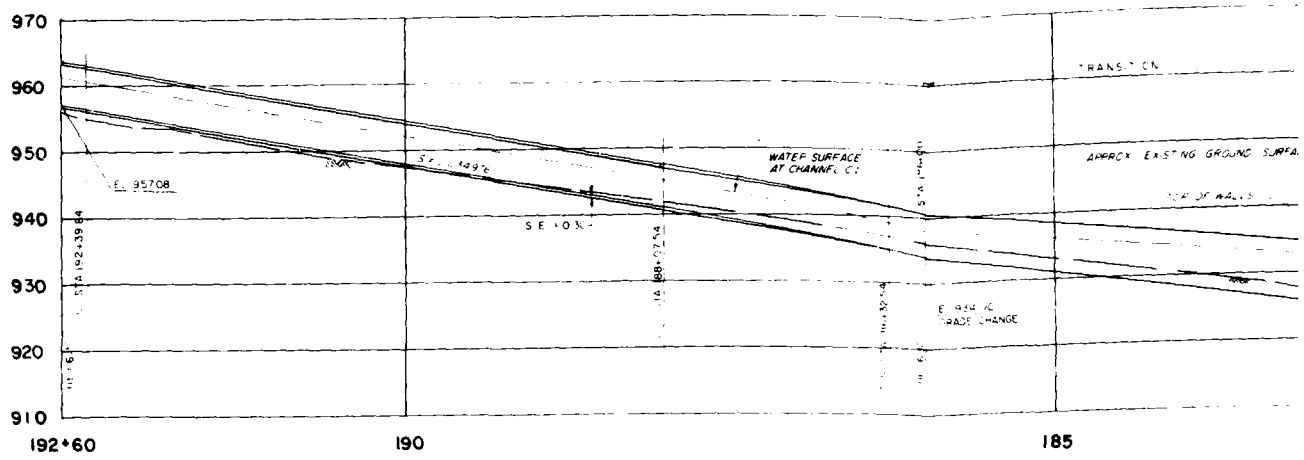
TYPICAL SECTION
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOCATION OF EXPLORATION
STA 206+39.58 TO STA 192+60

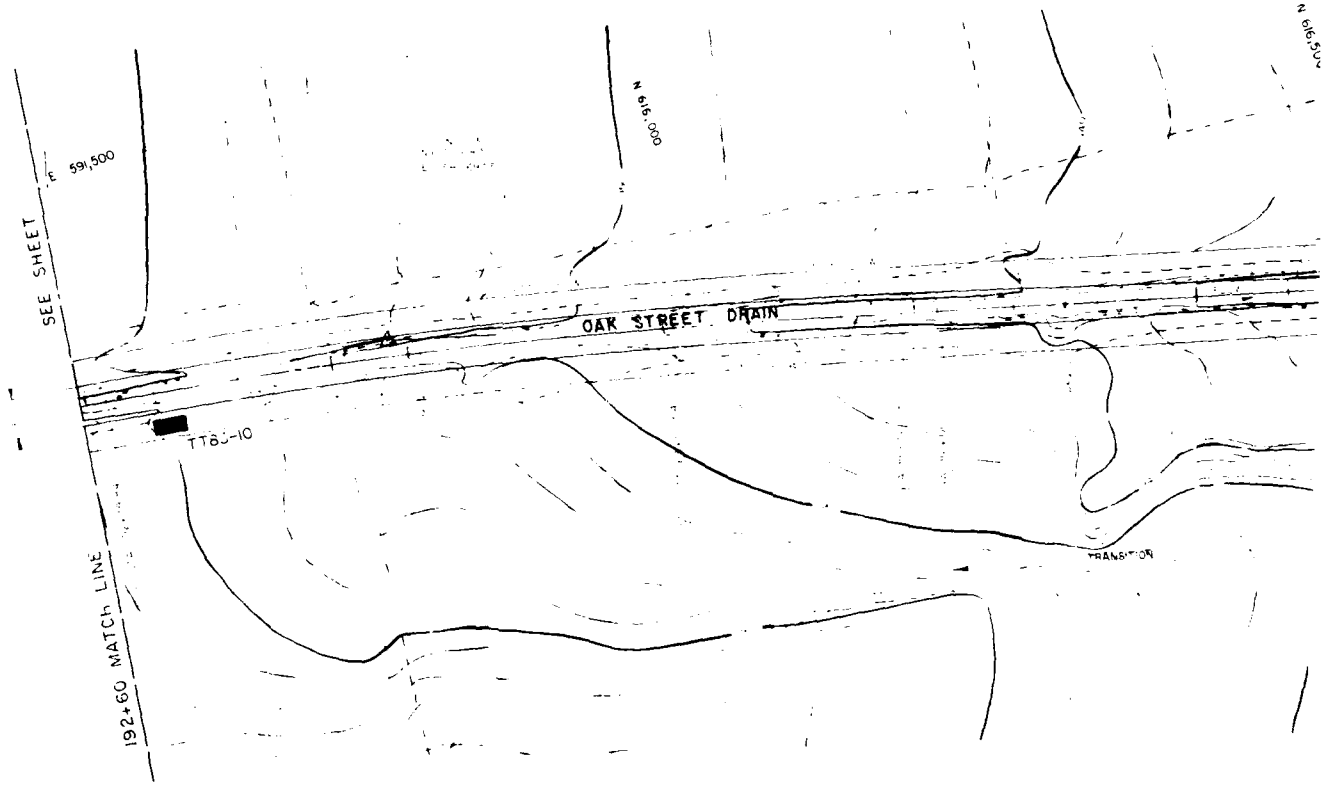
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



E CURVE DATA

CIRCULAR CURVE	SPIRAL CURVE NO 23
R = 4,000	
T = 216 16	T = 50 16
L = 432 30	L = 75 30

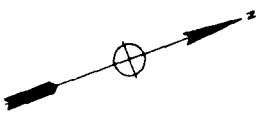
PROFILE



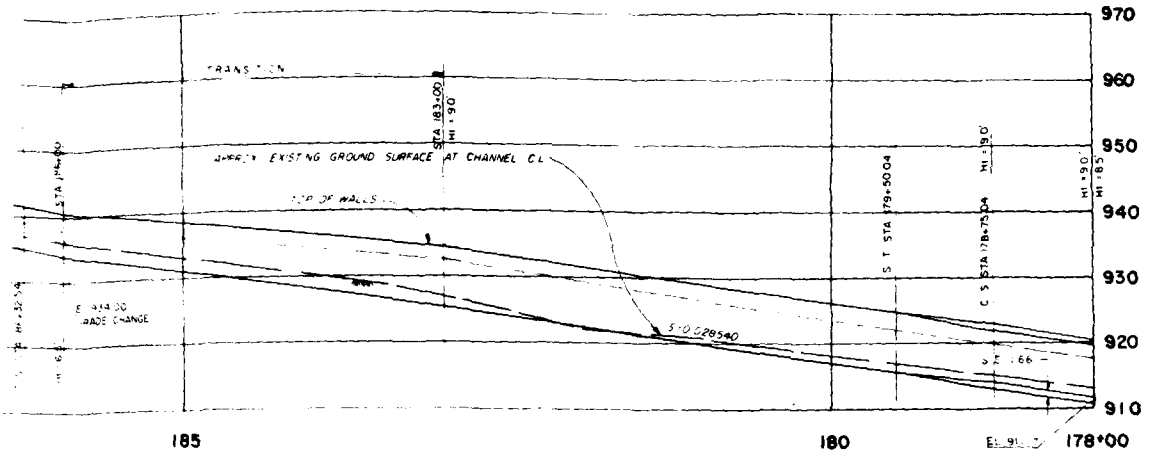
PLAN

HYDRAULIC ELEMENTS

STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
192+60	186+00	18' Rect.	.034976	4,300	8.6	4.4	35.9	4.1	39.3
186+00	183+00	Trans.	.028540	4,300	VARIES	4.1	39.3	6.8	27.6
183+00	178+00	18' Rect.	.028540	4,300	12.1	6.8	37.6	6.5	39.8



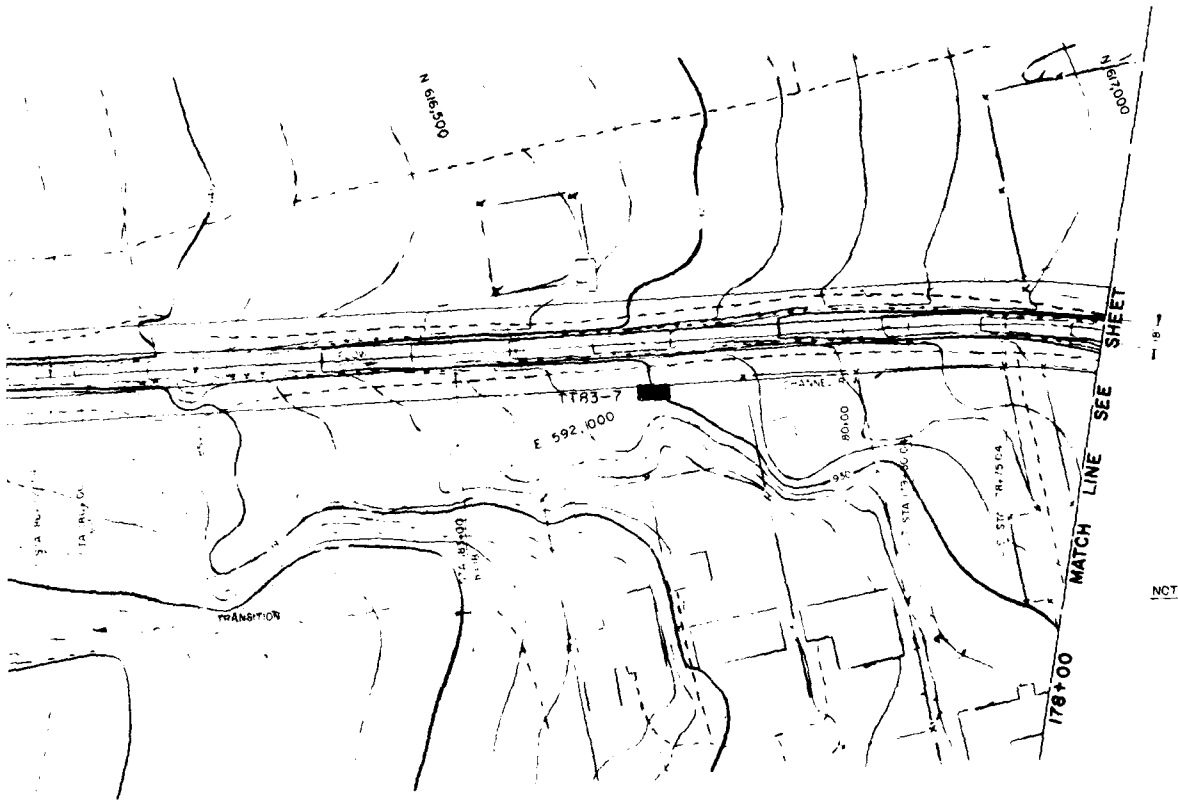
SEC



PROFILE

NOT TO SCALE 0 50 100 FEET

SCALE 0 50 100 FEET

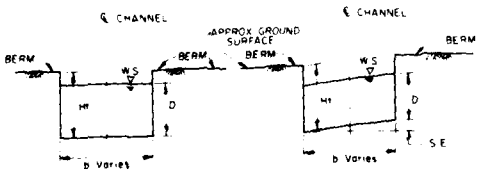


NOTES

1 SEE PLATE 3 FOR LEGEND

2 SEE PLATE 18 FOR LOGS OF EXPLORATION

PLAN



SECTION ON TANGENT SECTION ON CURVE

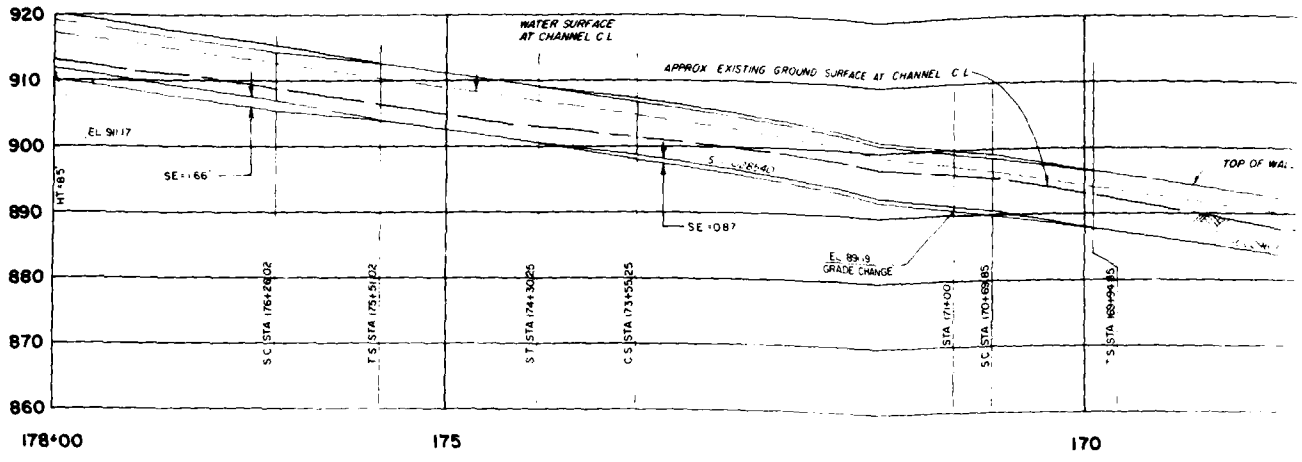
TYPICAL SECTIONS
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOCATION OF EXPLORATION
STA 192+60 TO STA 178+00

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



PROFILE

HORIZ SCALE 50 0 50 100 FEET

VERT SCALE 10 0 10 20 30 FEET

℄ CURVE DATA
I = 35°19' 3"

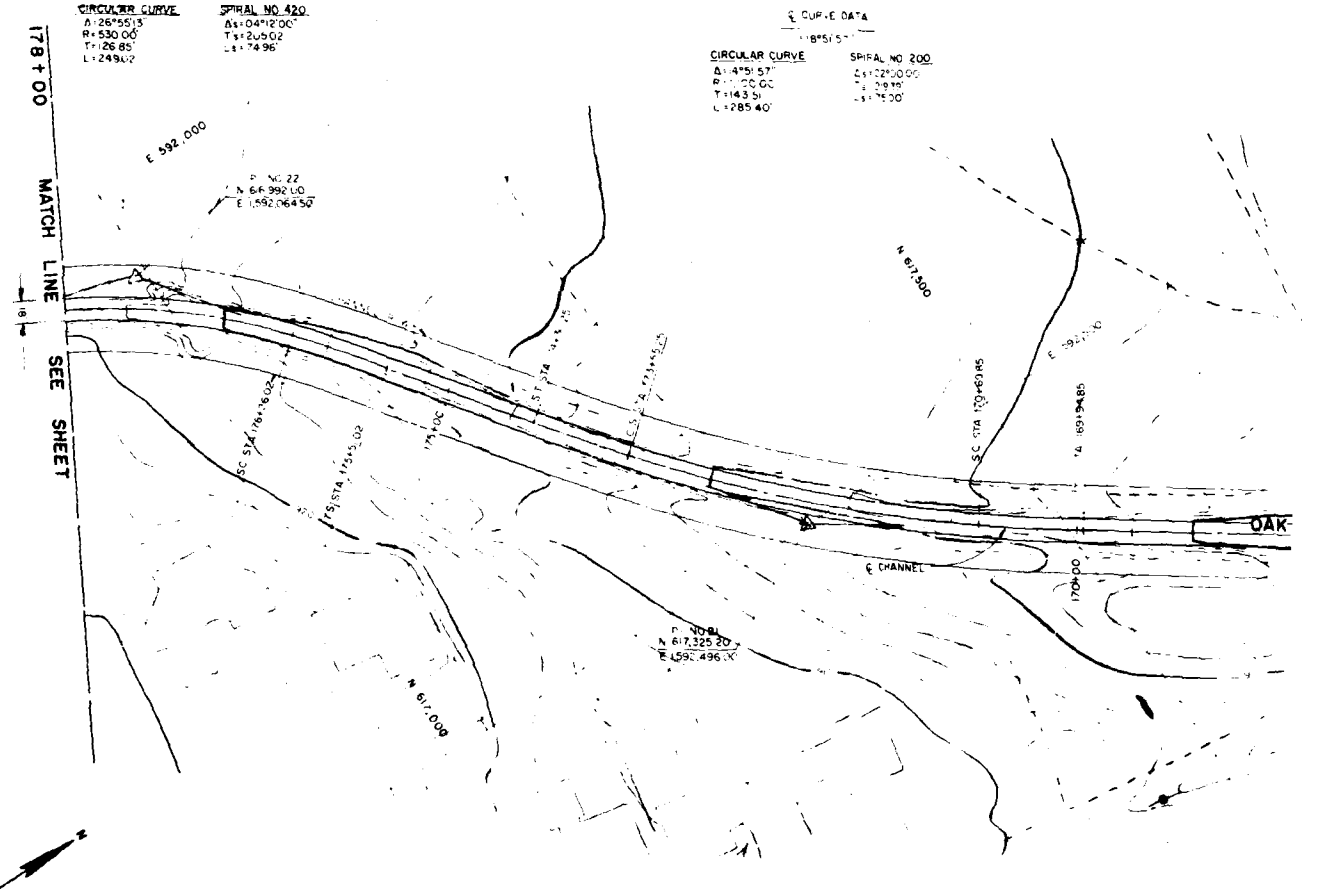
CIRCULAR CURVE
Δ = 26°55'13"
R = 530.00'
T = 126.85'
L = 249.02'

SPIRAL NO 420
Δs = 04°12'00"
Ts = 20.50'
Ls = 74.96'

℄ CURVE DATA
I = 18°51'57"

CIRCULAR CURVE
Δ = 4°51'57"
R = 1150.00'
T = 48.75'
L = 97.60'

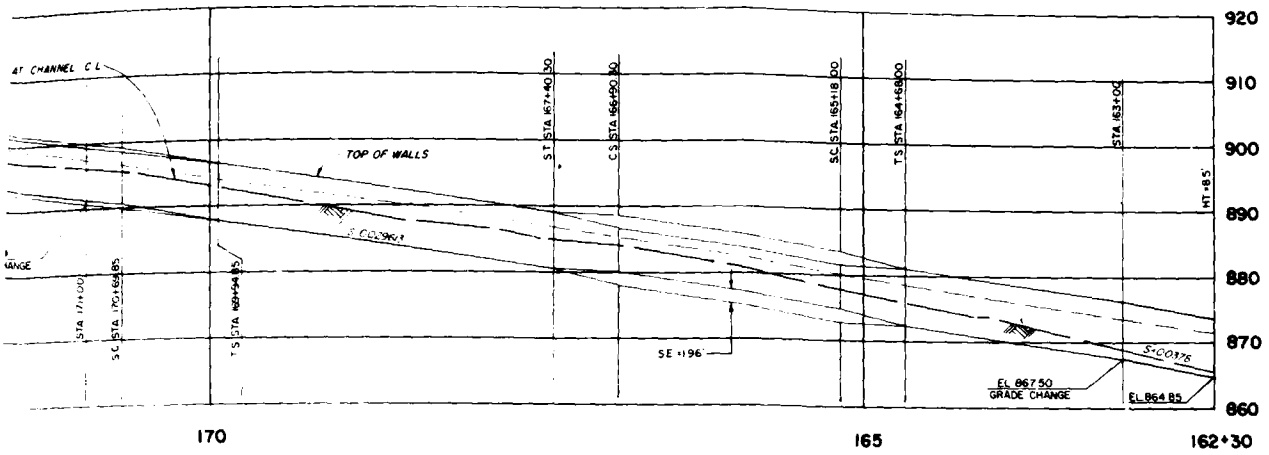
SPIRAL NO 200
Δs = 07°00'00"
Ts = 34.99'
Ls = 75.00'



PLAN

HYDRAULIC ELEMENTS

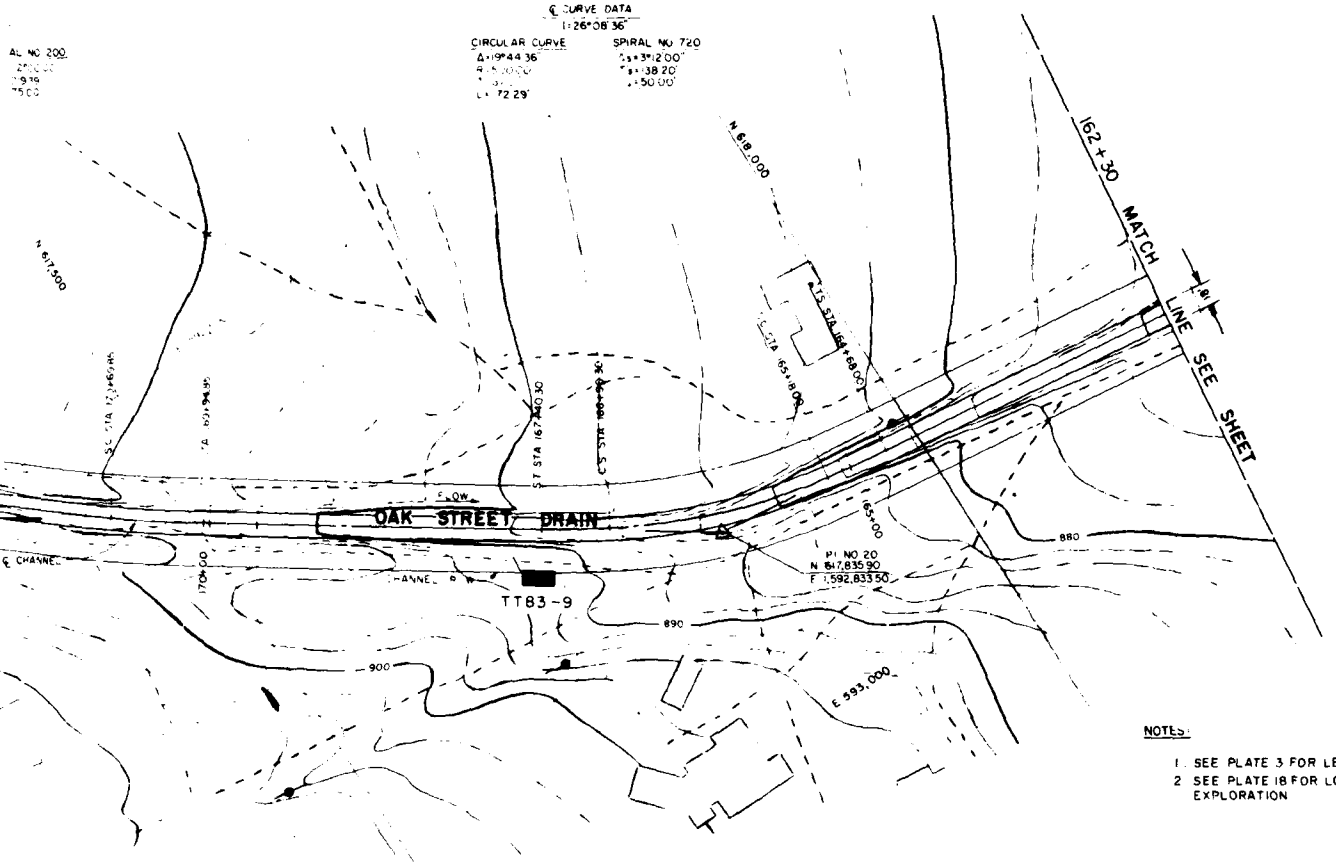
STA TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
178+00	171+00	18' Rect.	.028540	4,400	12.3	6.5	40.8	6.4	41.4
171+00	163+00	18' Rect.	.029613	4,400	12.3	6.4	41.4	6.4	41.9
163+00	162+30	18' Rect.	.037800	4,500	12.5	6.7	40.7	6.6	41.9



PROFILE

HORZ SCALE 50 0 50 100 FEET

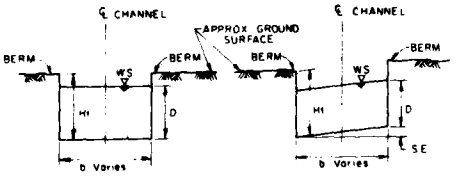
VERT SCALE 10 0 10 20 30 FEET



NOTES:

1. SEE PLATE 3 FOR LEGEND
2. SEE PLATE 18 FOR LOGS OF EXPLORATION

PLAN



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

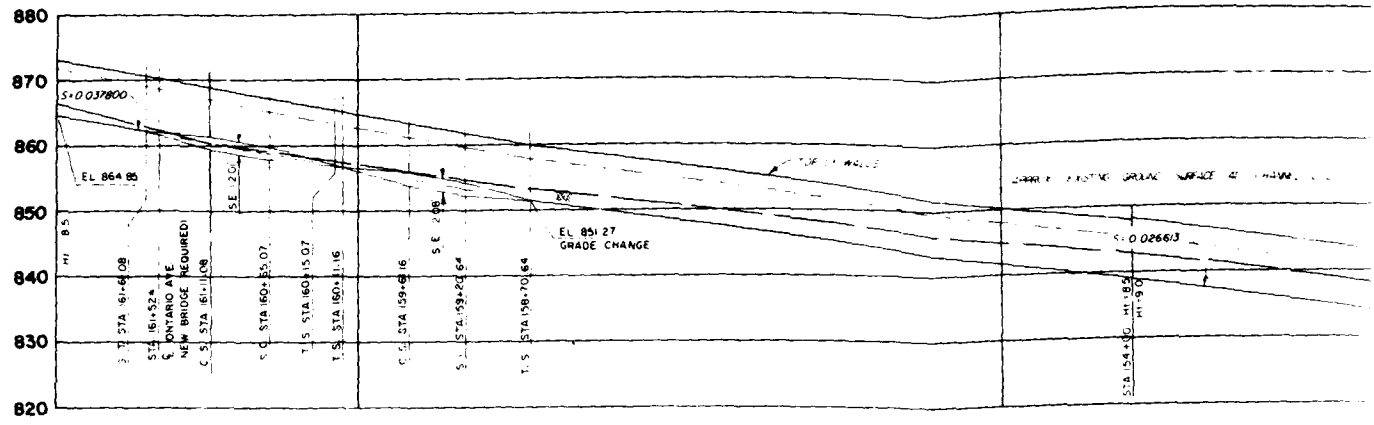
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOCATION OF EXPLORATION

STA 178+00 TO STA 162+30

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

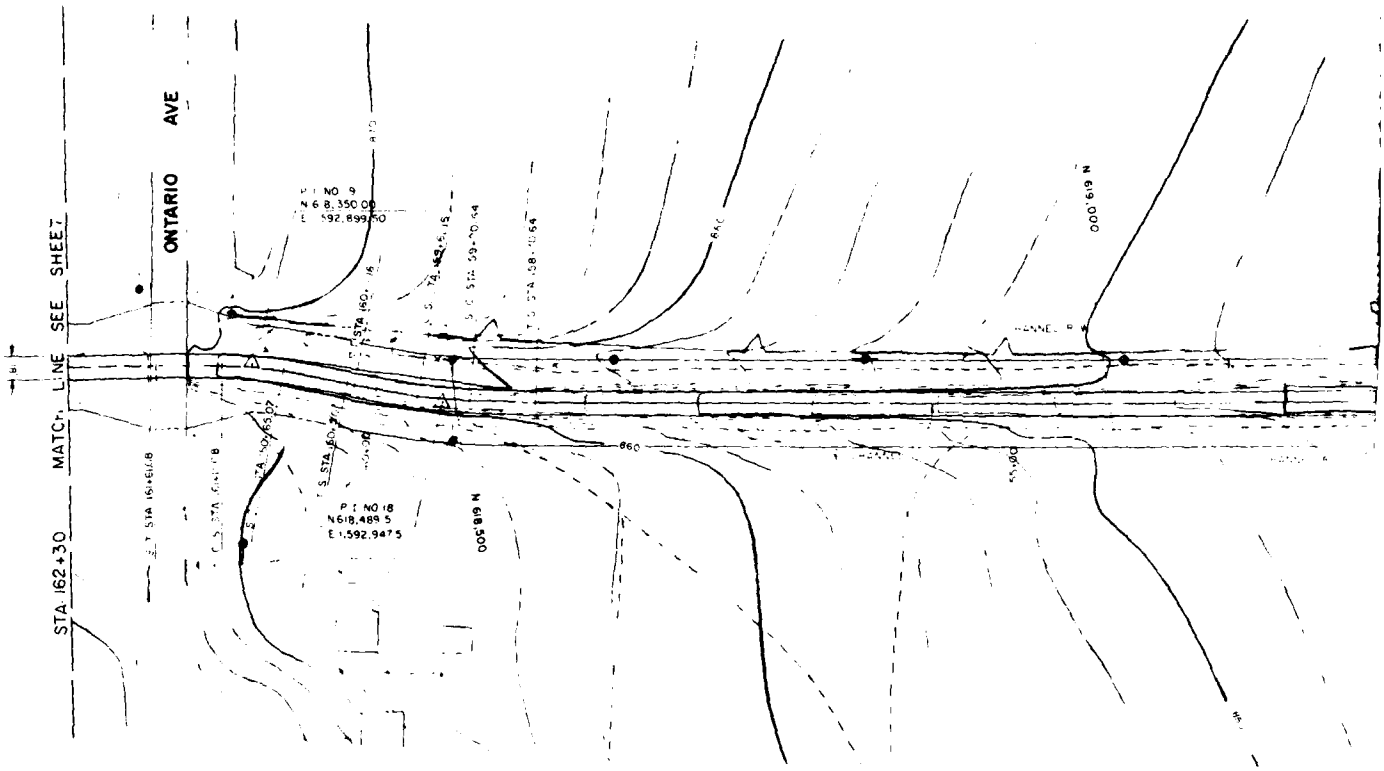


P I NO 9
℄ CURVE DATA

CIRCULAR CURVE	SPIRAL NO 720
Δ = 15° 16' 19"	Δs = 03° 2' 00"
R = 500 00	Ts = 73 19
T = 23 02	Ls = 50 00
L = 46 01	

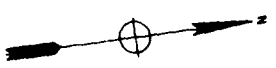
P I NO 18
℄ CURVE DATA

CIRCULAR CURVE	SPIRAL NO 720
Δ = 04° 38' 35"	Δs = 03° 12' 00"
R = 500 00	Ts = 70 42
T = 20 27	Ls = 50 00
L's = 40 52	

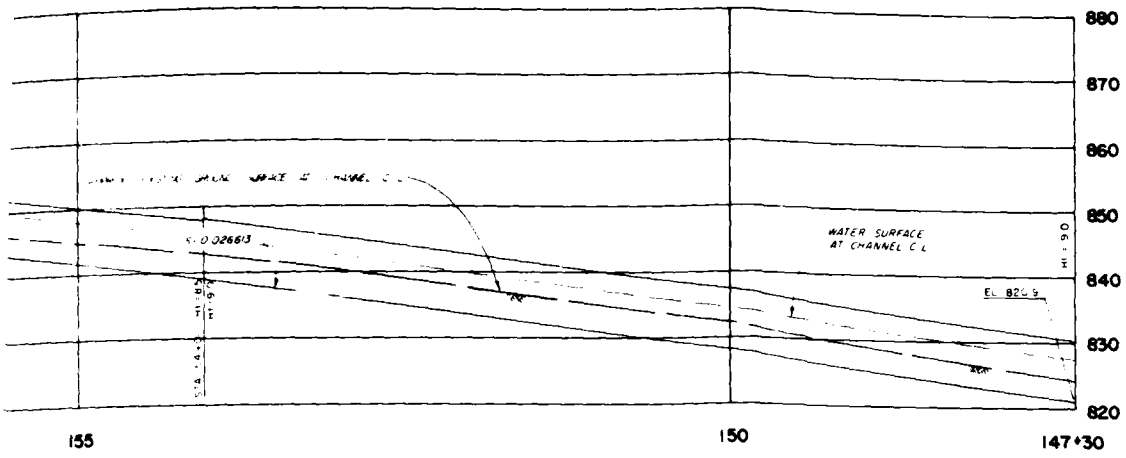


PLAN

HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
162+30	158+70.64	18' Rect.	.037800	4,500	12.5	6.1	40.9	6.3	43.8
158+70.64	158+00	18' Rect.	.037800	4,500	12.5	6.3	43.8	6.3	43.5
158+00	147+30	18' Rect.	.026613	4,500	12.5	6.3	43.5	6.6	41.4



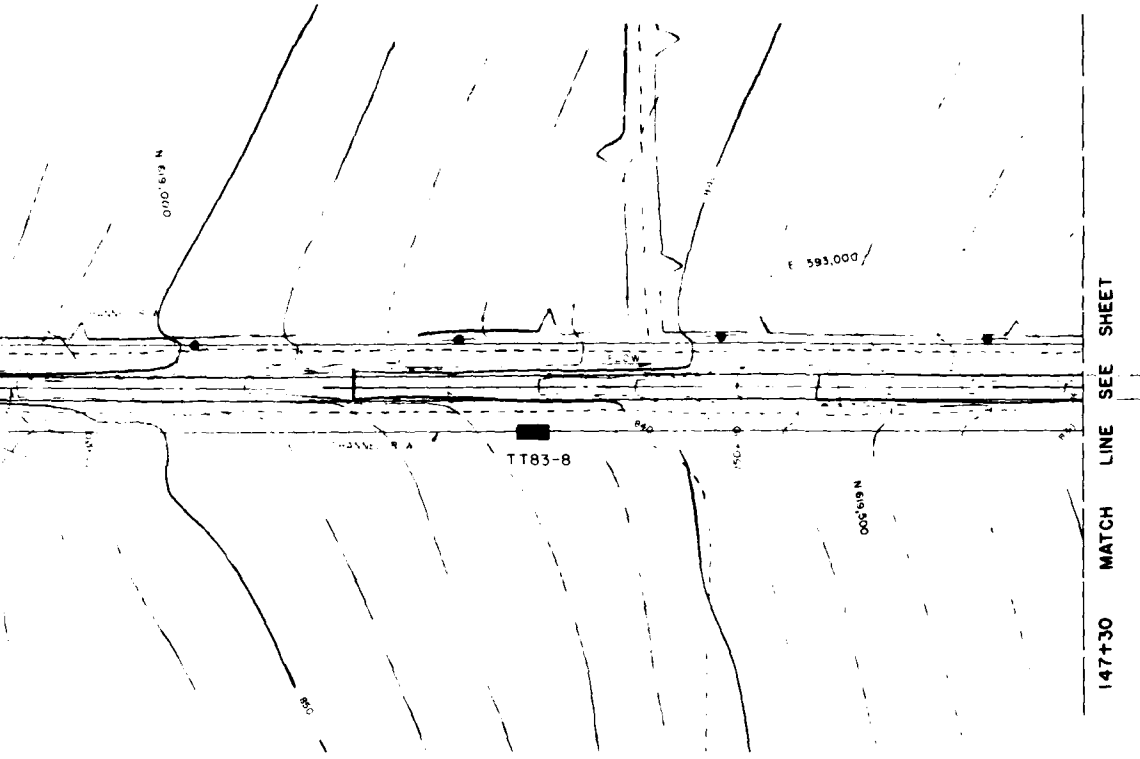
SECTION



PROFILE

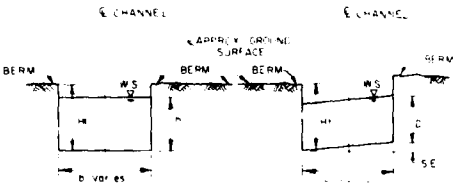
SCALE 50 0 50 100 FEET

E 5 0 10 30 FEET



NOTES
1. SEE PLATE 3 FOR LEGEND
2. SEE PLATE 18 FOR LOGS OF EXPLORATION

PLAN



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS
NOT TO SCALE

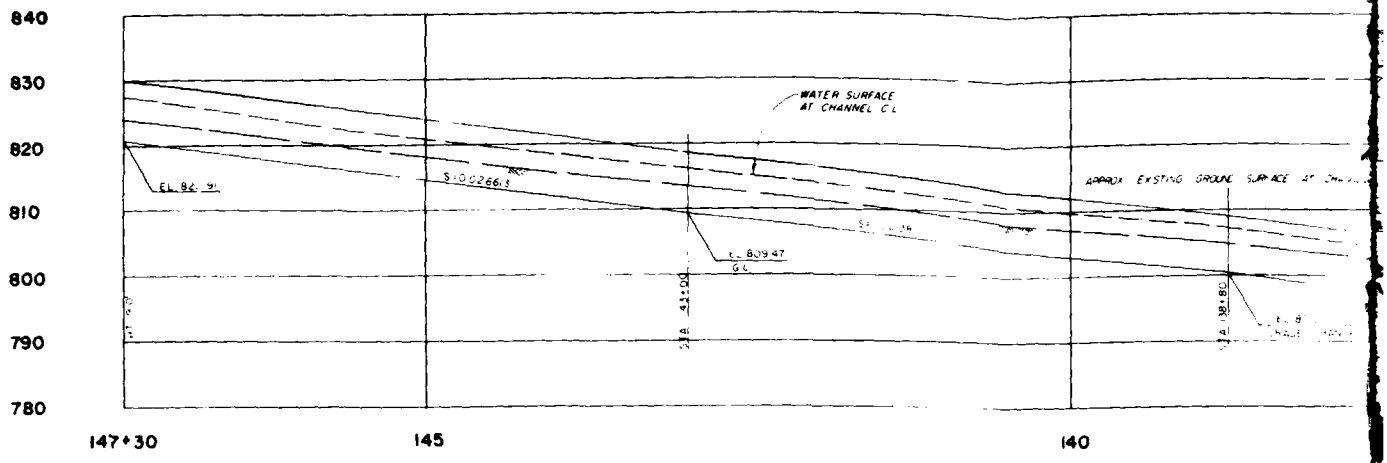
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

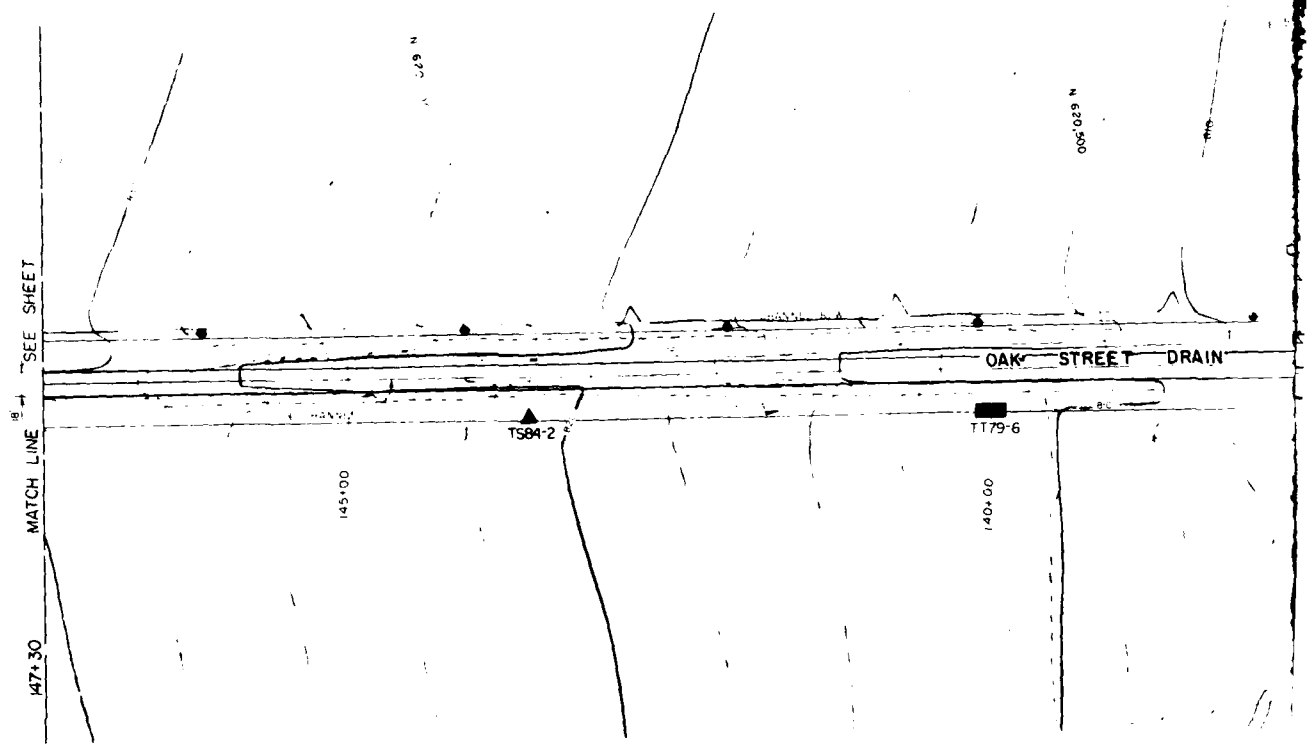
LOCATION OF EXPLORATION

STA 162+30 TO STA 147+30

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

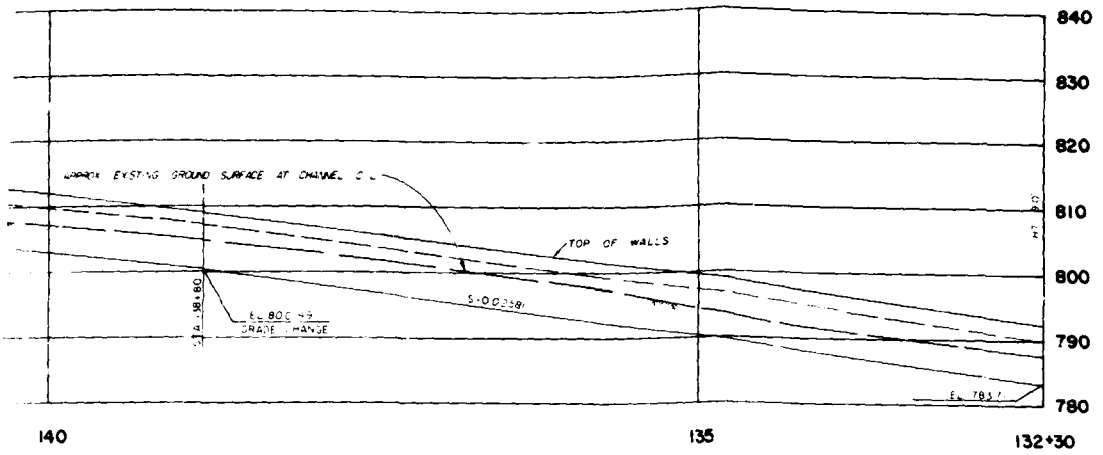


PROFILE



PLAN

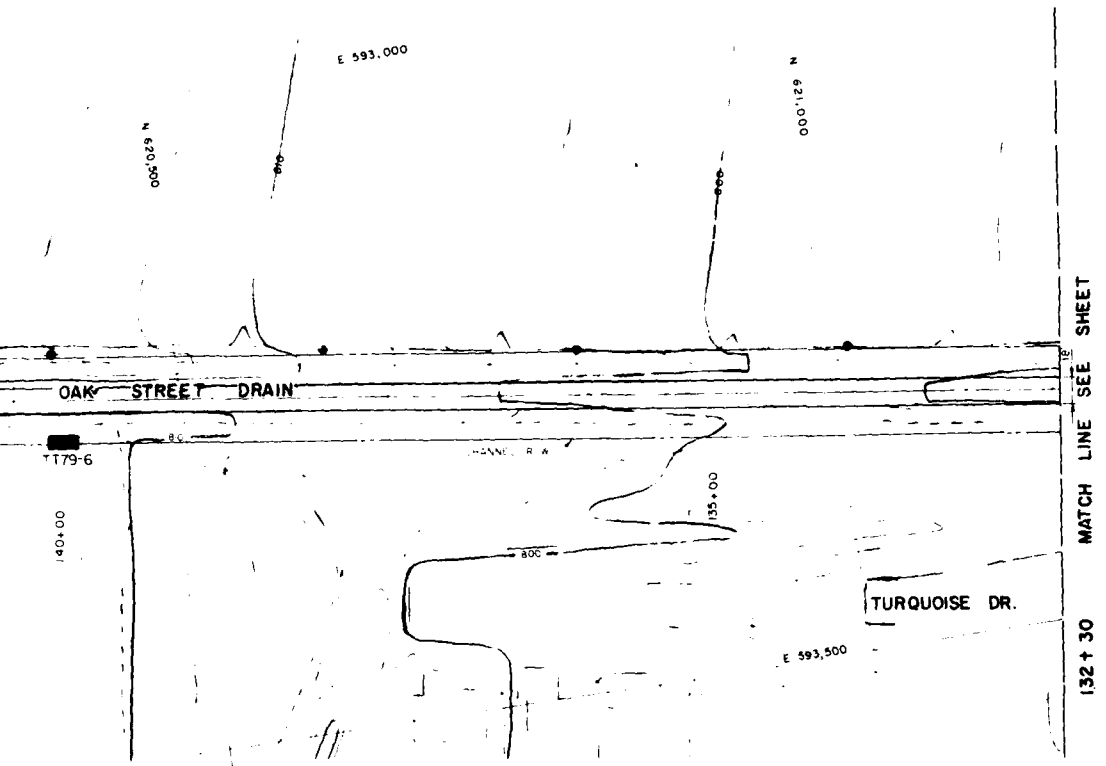
HYDRAULIC ELEMENTS									
STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	Va	DA	VA
147+30	143+00	18' Rect	026613	4,500	12.5	6.6	41.4	6.6	41.3
143+00	138+80	"	021380	"	12.5	6.6	41.3	6.8	39.6
138+80	132+30	"	025810	"	12.5	6.8	39.6	6.7	40.1



PROFILE

0 50 100 FEET

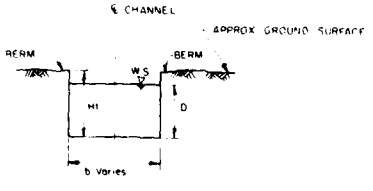
0 15 30 FEET



NOTES.

1. SEE PLATE 3 FOR LEGEND
2. SEE PLATE 17 FOR LOGS OF EXPLORATION
3. SEE FIGURE FOR CLASSIFICATION OF TS84-2

PLAN



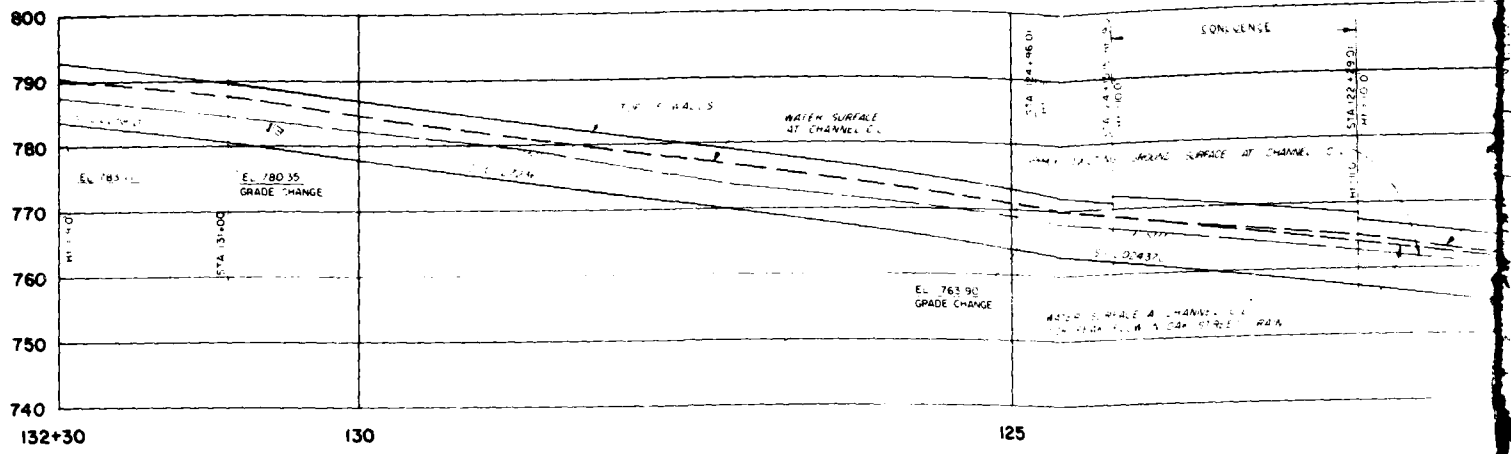
TYPICAL SECTION
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOCATION OF EXPLORATION
STA. 147 + 30 TO STA. 132 +30

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



HYDRAULIC ELEMENTS

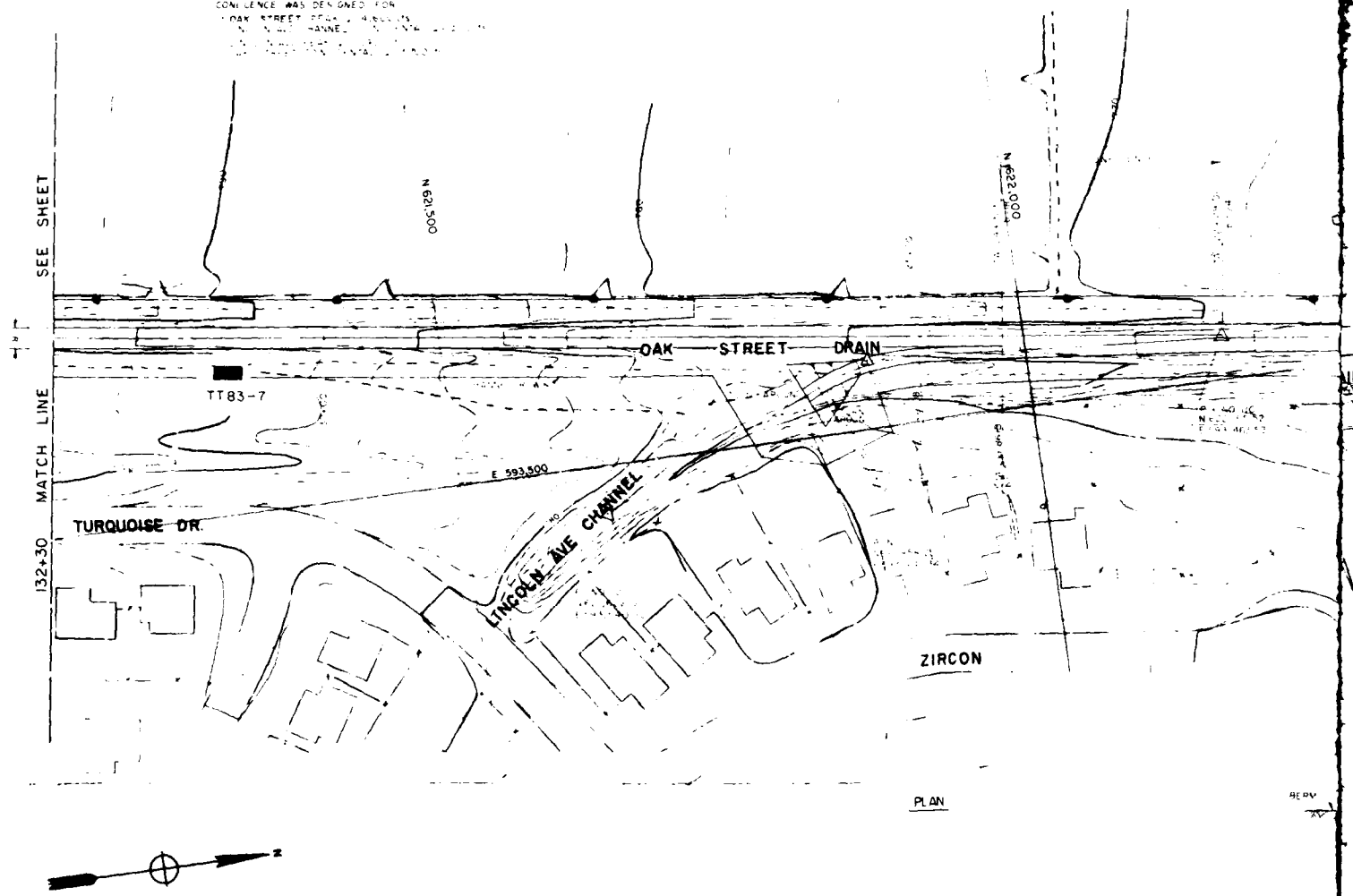
STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
132+30	131+00	18' Rect	.025810	4,500	12.5	6.7	40.1	6.7	40.1
131+00	124+96.01	18' Rect	.027236	4,600	12.7	7.0	39.0	6.8	40.6
124+96.01	124+15.15	18' Rect	.024370	4,600	12.7	6.8	40.6	6.8	40.6
124+15.15	122+29.01	CONFL	"	Varies	—	6.8	40.5	7.6	34.8
122+29.01	118+20	24' Rect	"	6,100	12.6	7.6	34.8	7.1	38.2
118+20	117+70	Trans	"	6,100	Varies	7.1	38.2	6.5	38.9
117+70	117+40	26' Rect	"	6,100	12.0	6.5	38.9	6.5	38.9

CONFLUENCE WAS DESIGNED FOR
OAK STREET DRAIN & MISSION
CHANNEL

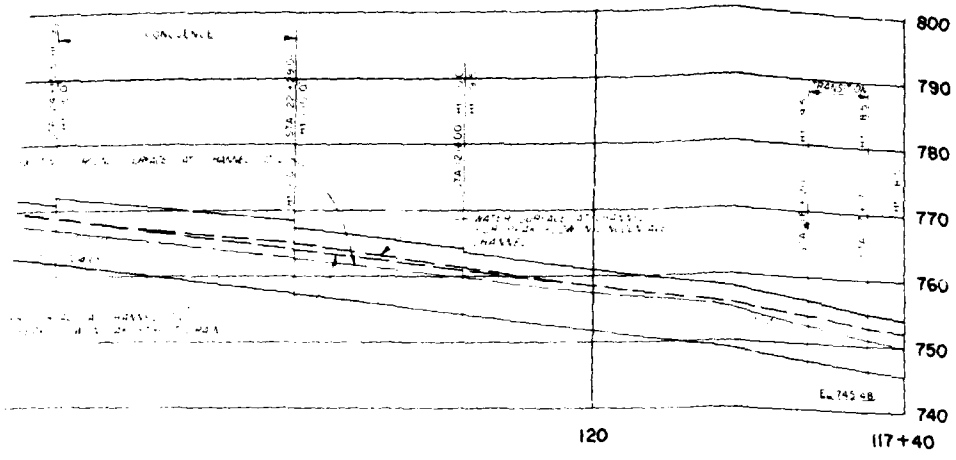
PROFILE

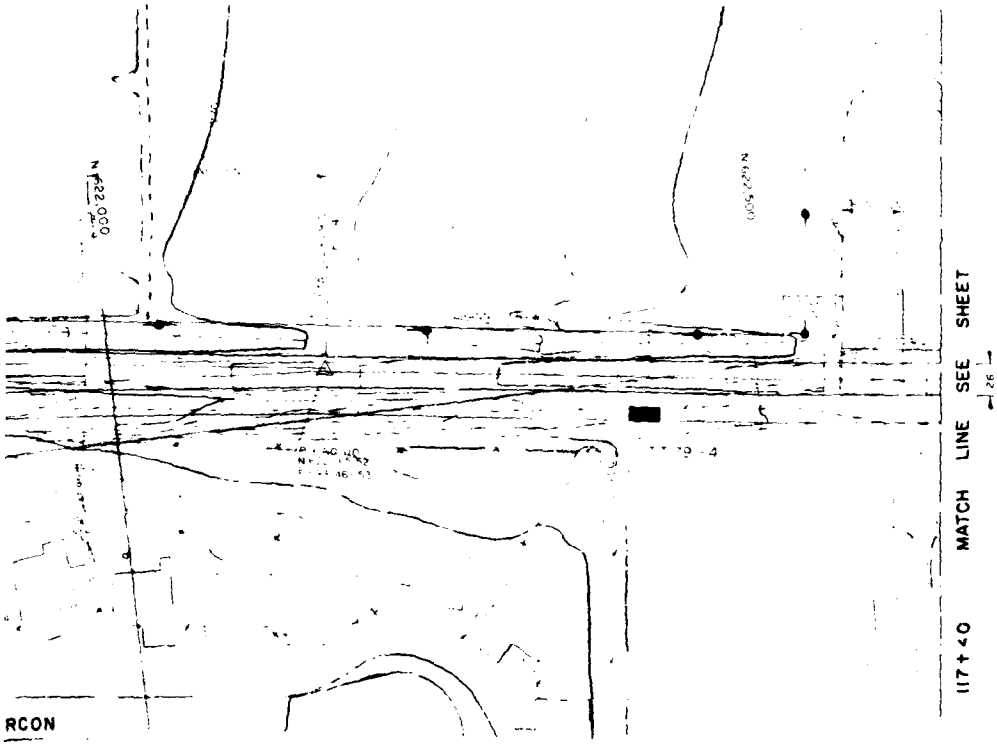
HORZ SCALE 1" = 50' FEET

VERT SCALE 1" = 5' FEET



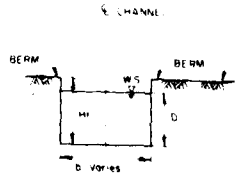
PLAN





SEE PLATE 3 FOR LEGEND

SEE PLATES 7 AND 8 FOR LOGS OF EXPLORATION



TYPICAL SECTION
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

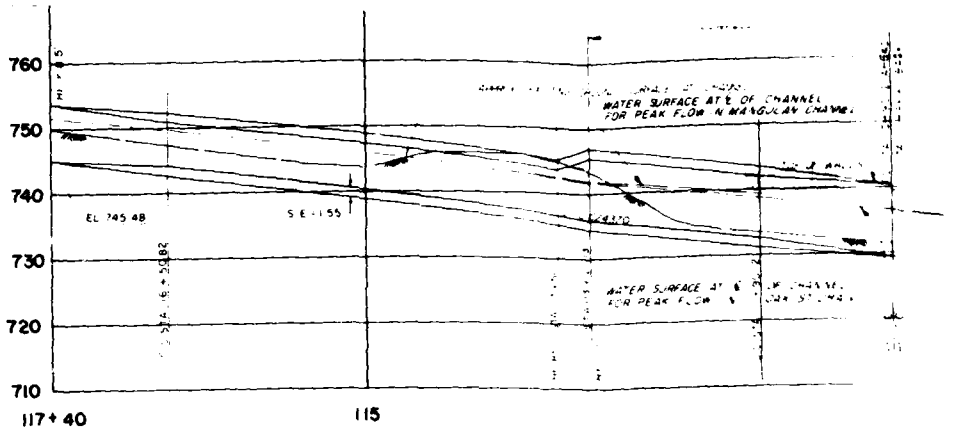
OAK STREET DRAIN

LOCATION OF EXPLORATION
STA 132+30 TO STA 117+40

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

APPENDIX B

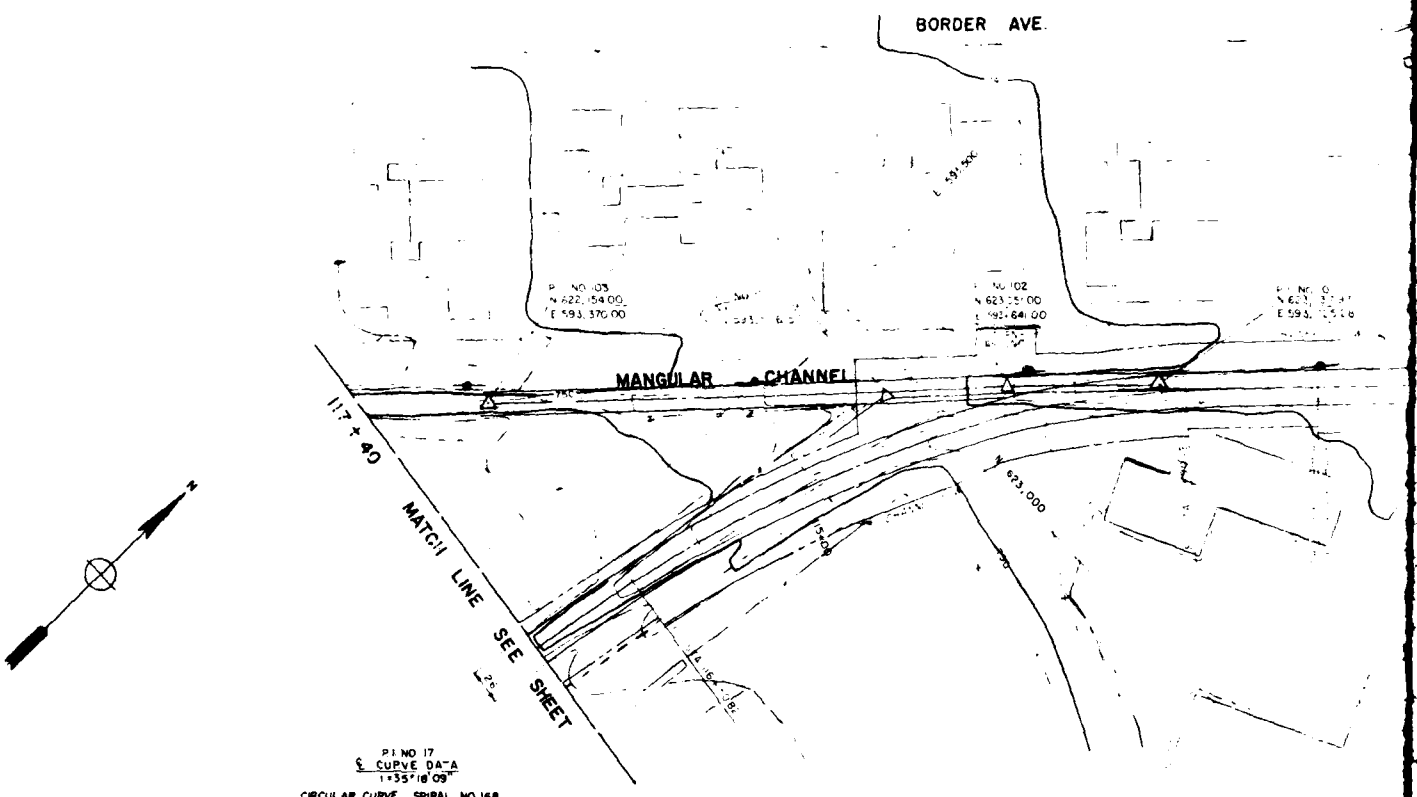
PLATE 8



HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
117+40	113+21.13	26'Rect	.024370	6100	12.0	6.5	38.9	6.3	40.1
113+21.13	111+90.12	Confl	.024370	varies	~	6.3	40.1	7.7	37.1
111+90.12	109+.19	26'Rect	.024370	7100	13.2	7.7	37.1	7.4	39.2

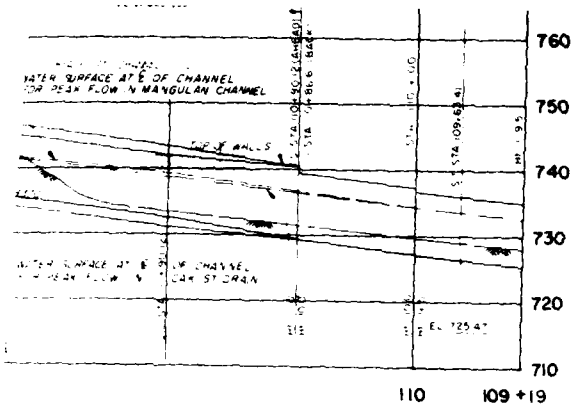
Confluence was designed for
1 Oak Street Drain Peak Q = 6100 cfs
Mangular Channel Conc Q = 1000 cfs
2 Mangular Channel Peak Q = 1700 cfs
Oak Street Drain Conc Q = 5400 cfs

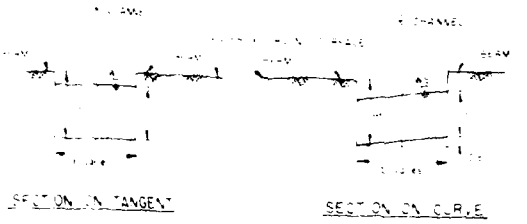
PROFILE



PLAN

SAFETY PAYS

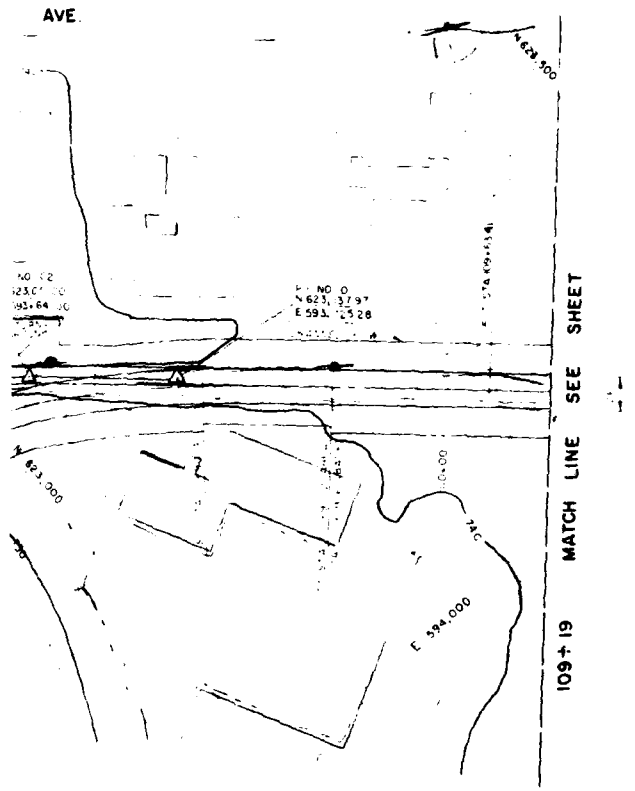




SECTION ON TANGENT

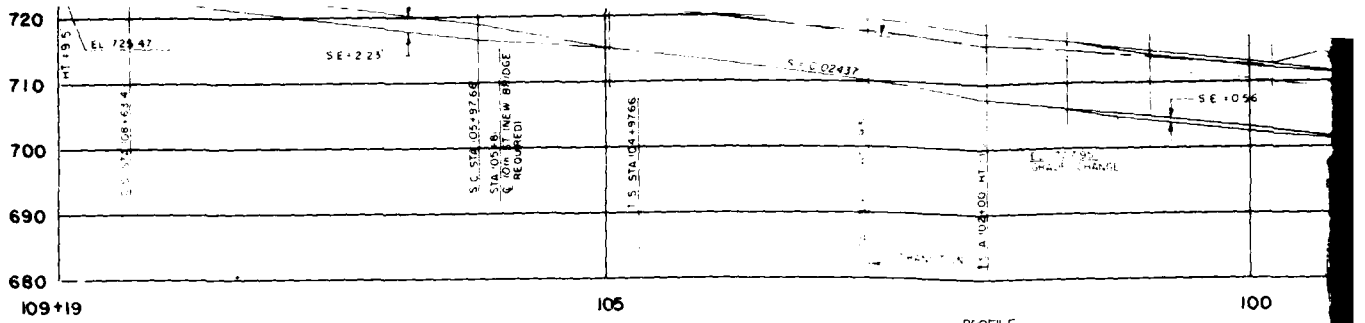
SECTION ON CURVE

TYPICAL SECTIONS



SANTA ANA RIVER, CALIFORNIA PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN LOCATION OF EXPLORATION STA 117+40 TO STA 109+19
U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

SAFETY PAYS



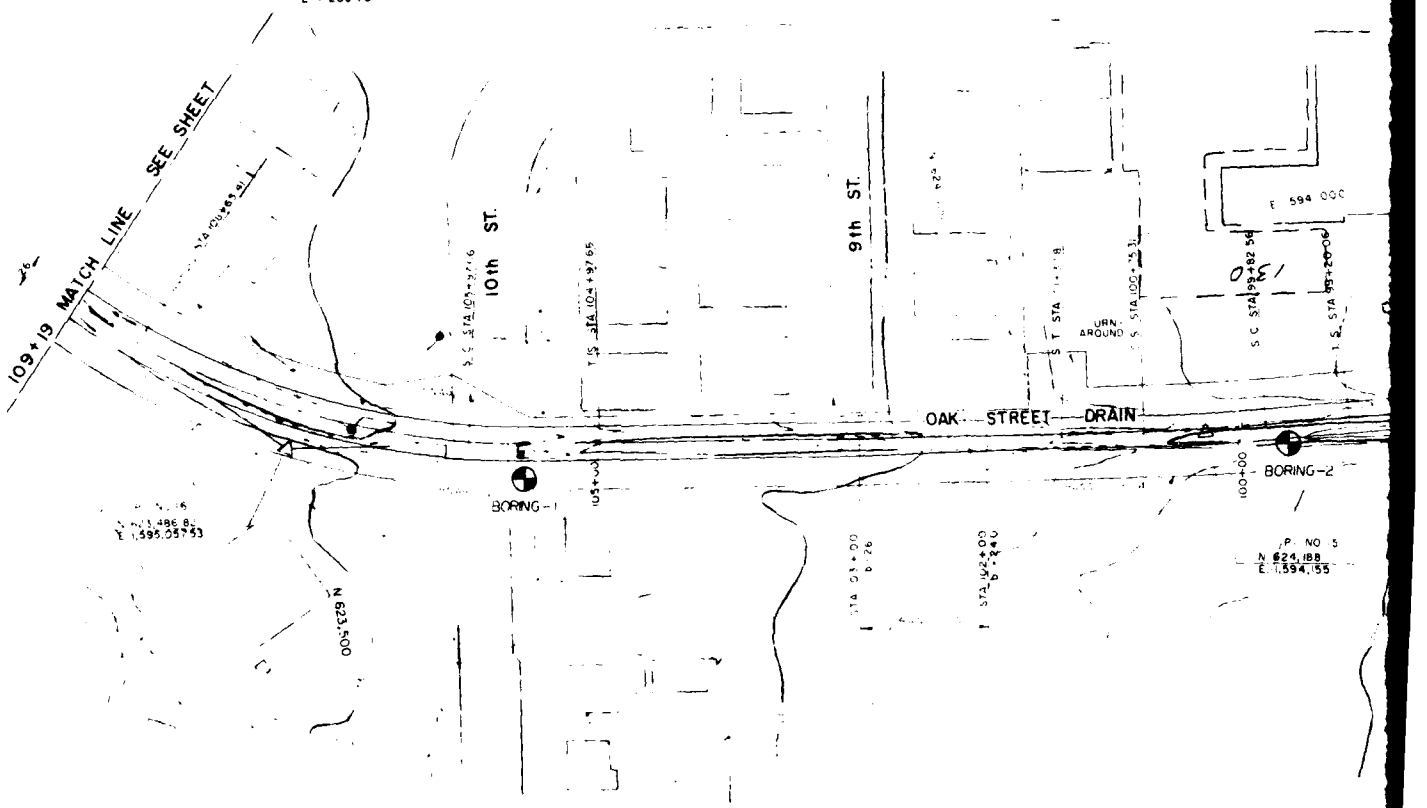
P.I. NO 6
Δ CURVE DATA
35° 19' 58"

CIRCULAR CURVE	SPIRAL NO 280
Δ = 25° 22' 38"	Δ_s = 04° 58' 40"
R = 600.00'	T_s = 239.16'
T = 135.09'	L_s = 100.00'
L = 265.75'	

PROFILE

HORIZ SCALE 0 50 100 FEET

VERT SCALE 10 20 30 FEET



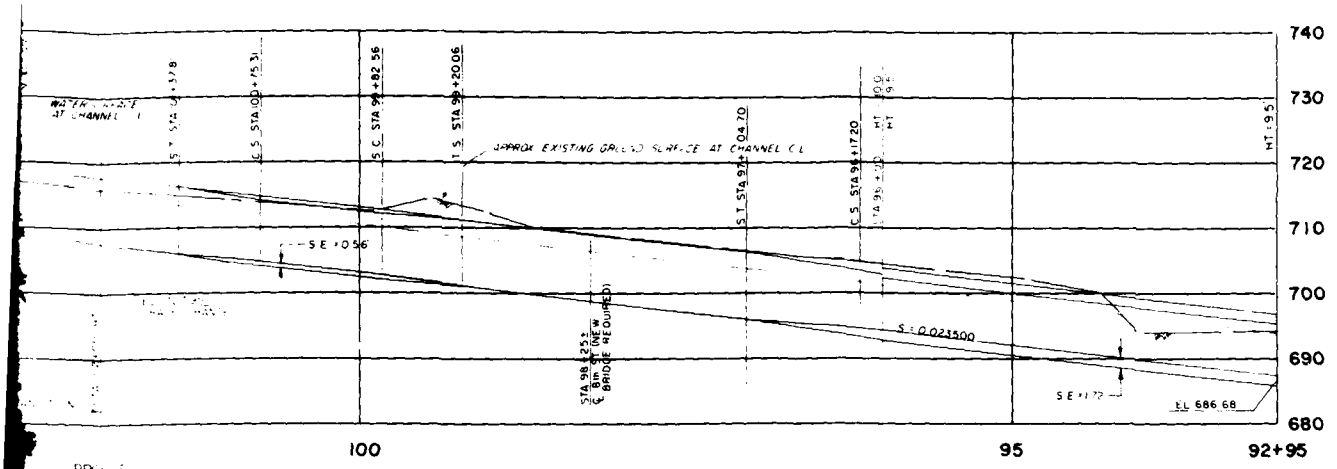
PLAN

SECTION ON

HYDRAULIC ELEMENTS

STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
109+.9	103+00	26' Rect	024370	5,000	11.7	7.4	39.2	7.7	41.6
103+00	102+00	Trans.	024370	5,000	Varies	7.1	41.6	7.7	41.4
102+00	92+95	24' Rect	023500	5,000	11.4	7.7	41.4	7.5	42.9

SAFETY PAYS

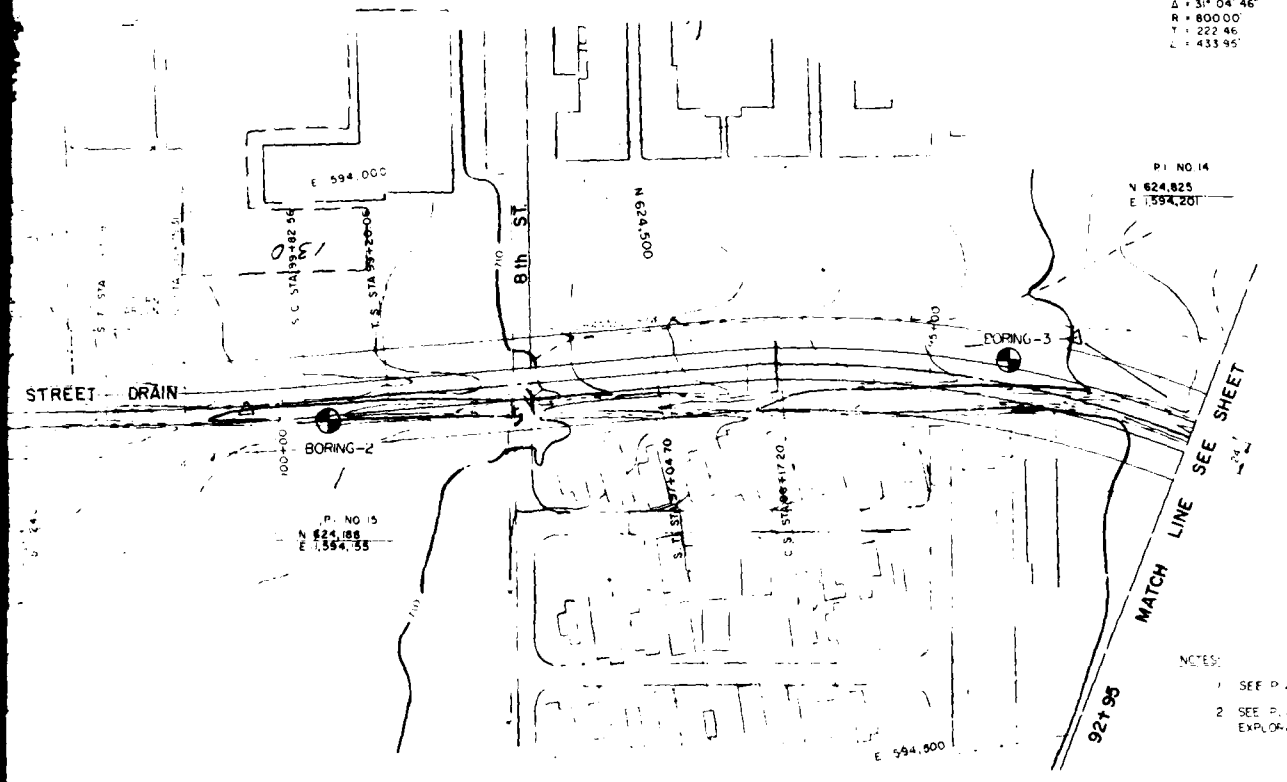


P I NO 15
℄ CURVE DATA
I = 03° 47' 01"

CIRCULAR CURVE	SPIRAL NO 113
Δ = 02° 12' 51"	Δ_s = 00° 47' 05"
R = 2400	T_s = 108 90'
T = 46 38	L_s = 62 5'
L = 92 75'	

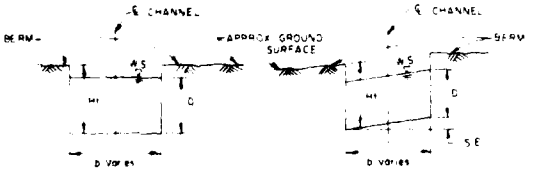
P I NO 14
℄ CURVE DATA
I = 37° 31' 52"

CIRCULAR CURVE	SPIRAL NO 237
Δ = 31° 04' 46"	Δ_s = 03° 13' 33"
R = 800 00'	T_s = 314 39
T = 222 46	L_s = 87 50
L = 433 95'	



NOTES:
1 SEE PLATE 3 FOR LEGEND
2 SEE PLATE 9 FOR LOGS OF EXPLORATION

PLAN



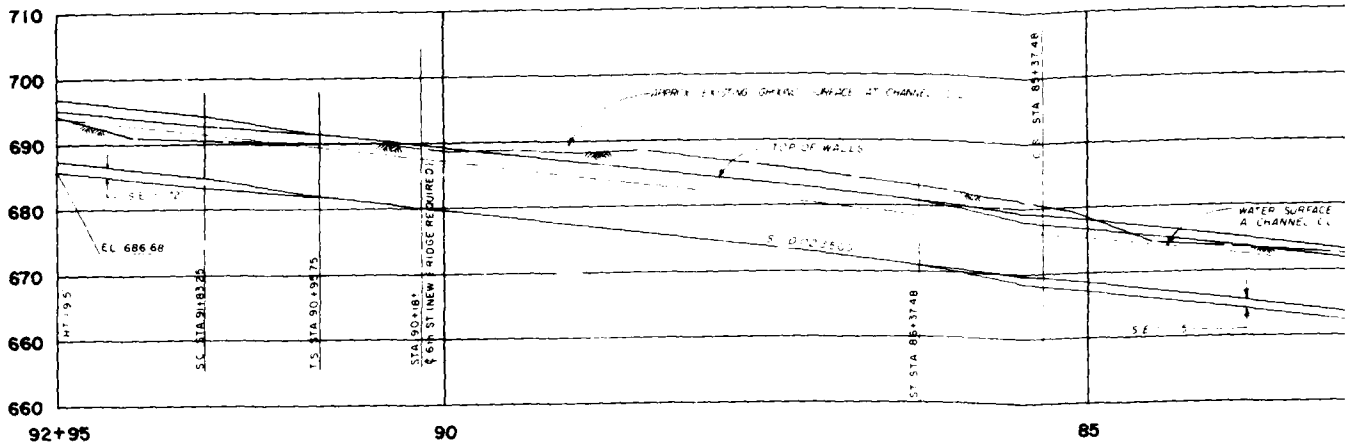
TYPICAL SECTIONS
NOT TO SCALE

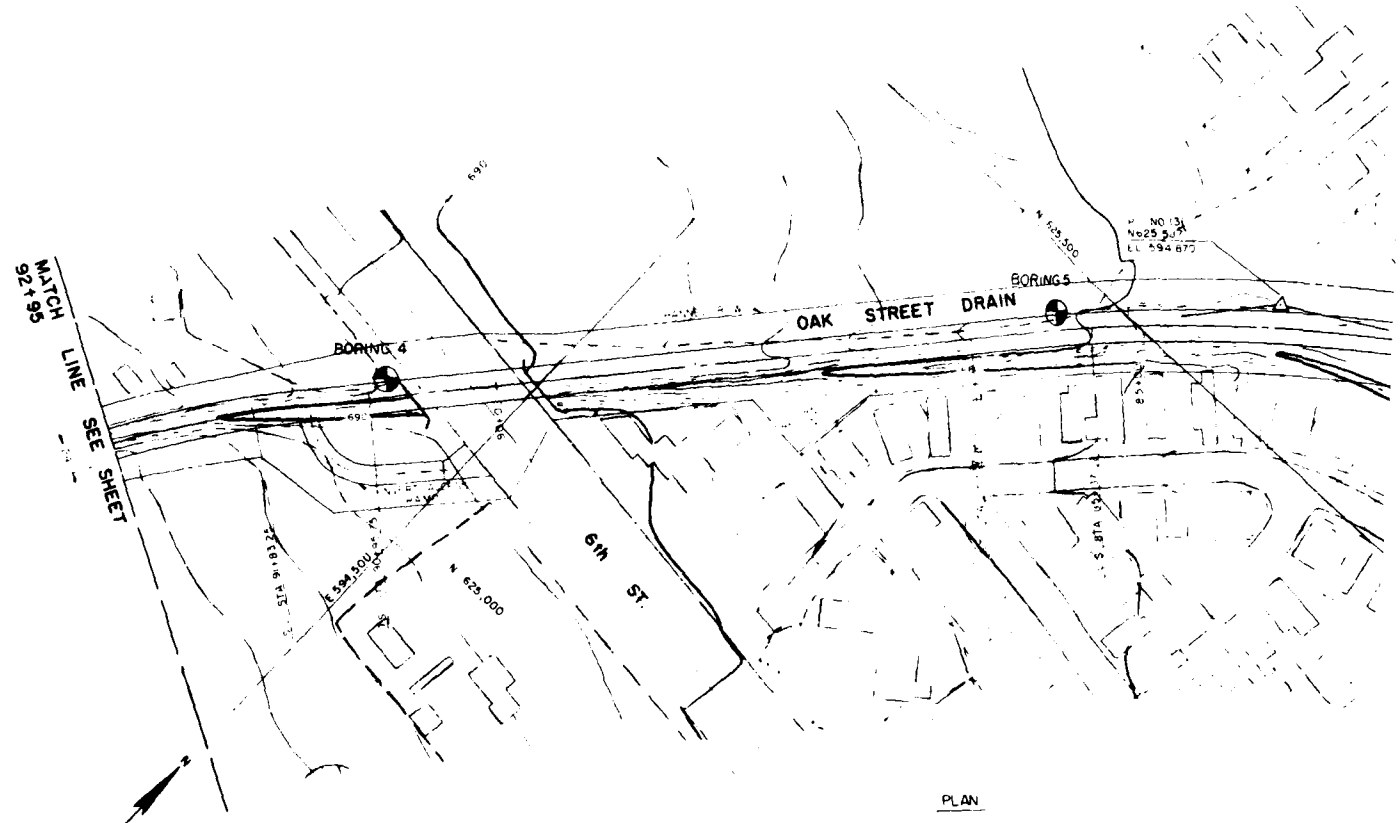
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

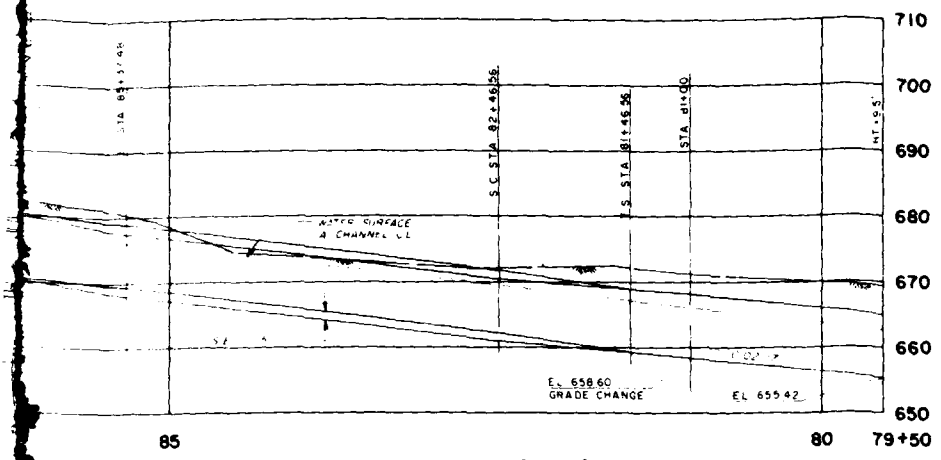
LOCATION OF EXPLORATION
STA. 109+19 TO STA. 92+95

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



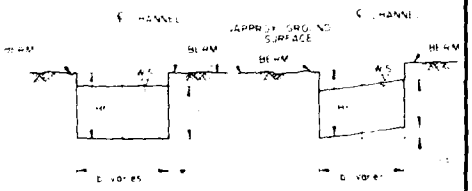


HYDRAULIC ELEMENTS						n = 0.014			
STA. TO STA.		SECTION	SLOPE	Q	Dc	Da	Va	Da	Va
92+95	81+00	24'Rect	.023500	7,100	14.0	7.5	42.9	7.4	43.0
81+00	79+50	24'Rect	.021170	7,100	14.0	7.4	43.0	7.5	42.8



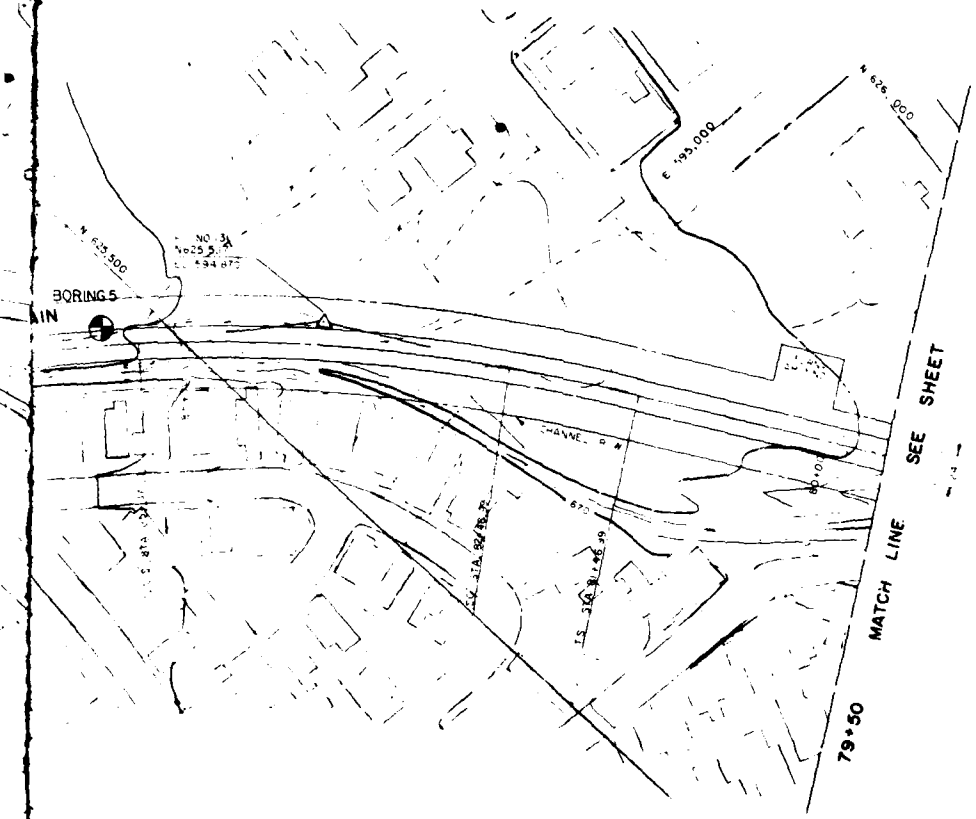
P.I. NO 13
℄ CURVE DATA
I = 18° 47' 25"

CIRCULAR CURVE	SPIRAL NO 139
D = 3° 50' 55"	θ_s = 2° 28' 16"
R = 1200.00	T_s = 246.85'
T = 145.73	L_s = 100.00
L = 290.03	



SECTION ON TANGENT SECTION ON CURVE

TYPICAL SECTIONS

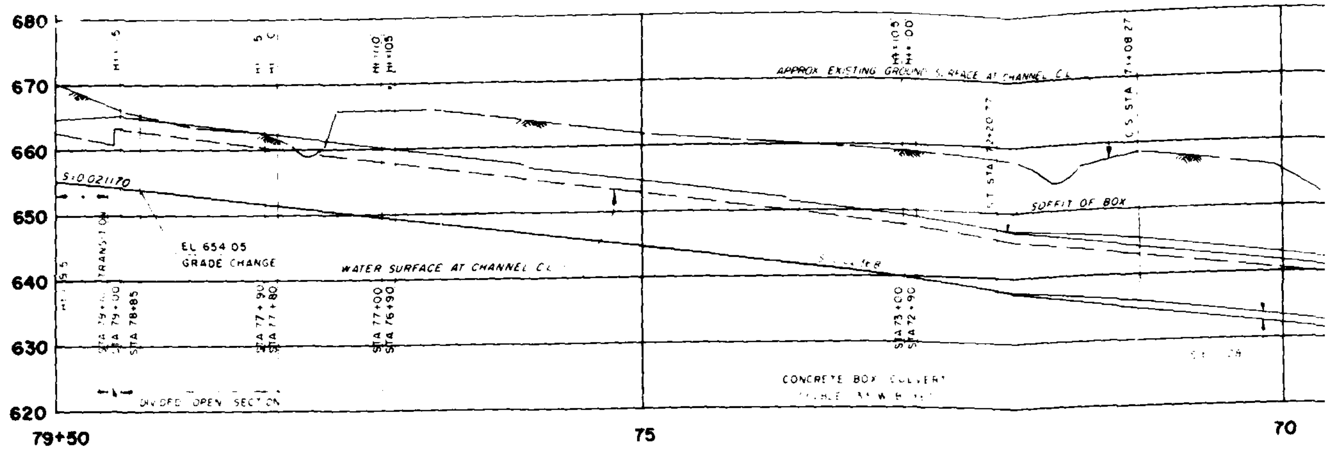


NOTES
1 SEE PLATE 3 FOR LEGEND
2 SEE PLATE 19 FOR LOGS OF EXPLORATION

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN

LOCATION OF EXPLORATION
STA 92+95 TO STA 79+50

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



PROFILE

HORIZ SCALE FEET

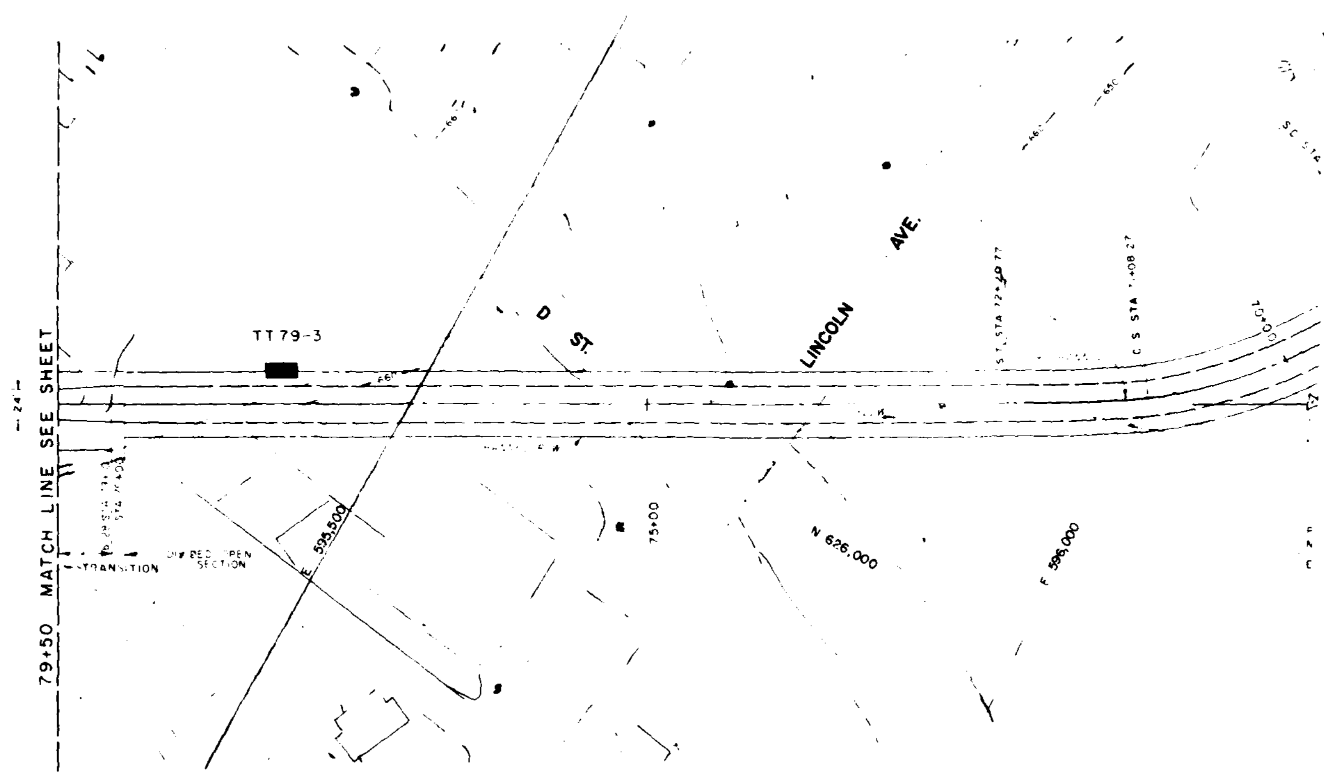
VERT SCALE FEET

STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						DA	VA	DA	VA
79+50	79+[illegible]	TRANS	[illegible]	[illegible]	VARIES	[illegible]	42.8	[illegible]	43.5
79+[illegible]	79+00	[illegible] RECT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28
79+00	78+85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.3	[illegible]
78+85	67+[illegible]	8 x [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.4
67+[illegible]	67+30	TRANS	[illegible]	[illegible]	VARIES	[illegible]	[illegible]	[illegible]	[illegible]
67+30	66+90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

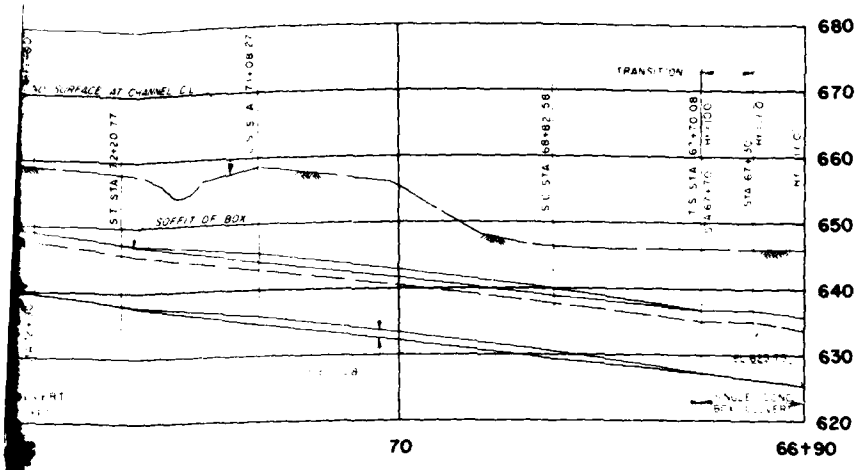
P.I. No 12
℄ CURVE DATA
Δ = 47° 37' 40"

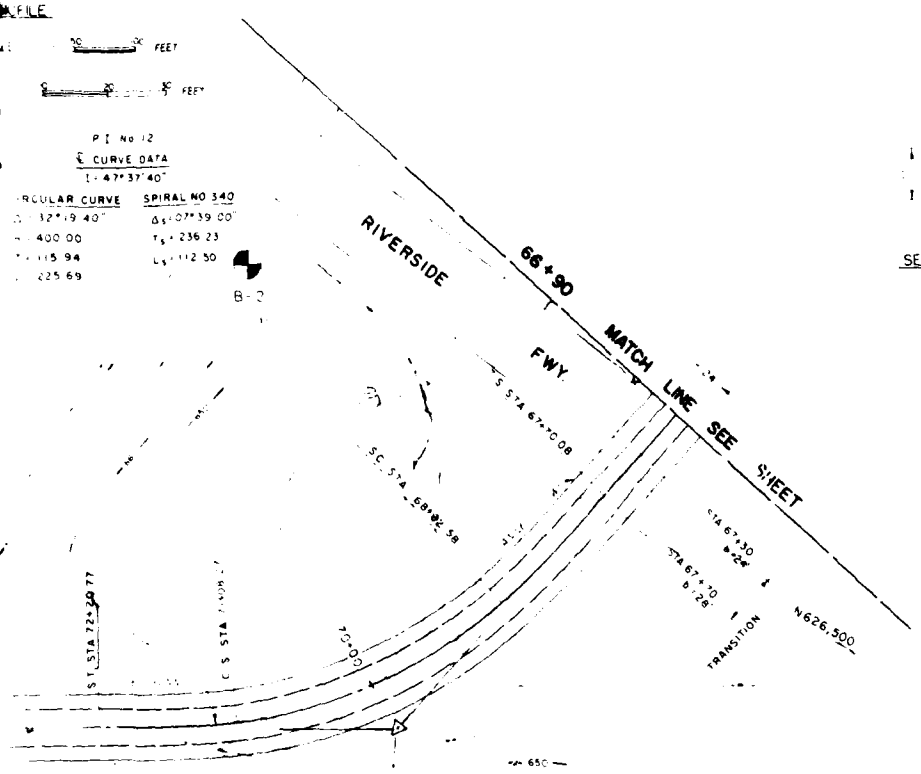
CIRCULAR CURVE	SPIRAL NO 340
Δ = 32° [illegible]	Δ_s = 07° 39' 00"
R = 4[illegible]	T_s = 236.23
T = [illegible] 5.94	L_s = 112.50
L = [illegible] 5.69	

B-2

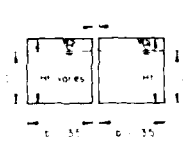


PLAN

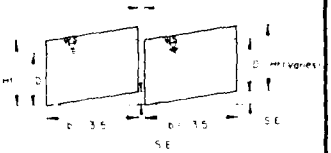




PLAN

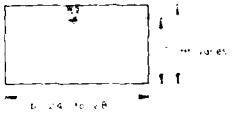


SECTION ON TANGENT

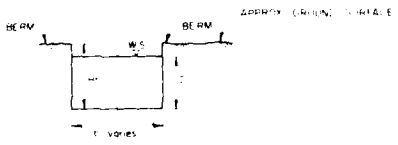


SECTION ON CURVE

TYPICAL DOUBLE BOX SECTIONS
NOT TO SCALE



TYPICAL BOX SECTION



TYPICAL OPEN SECTION
NOT TO SCALE

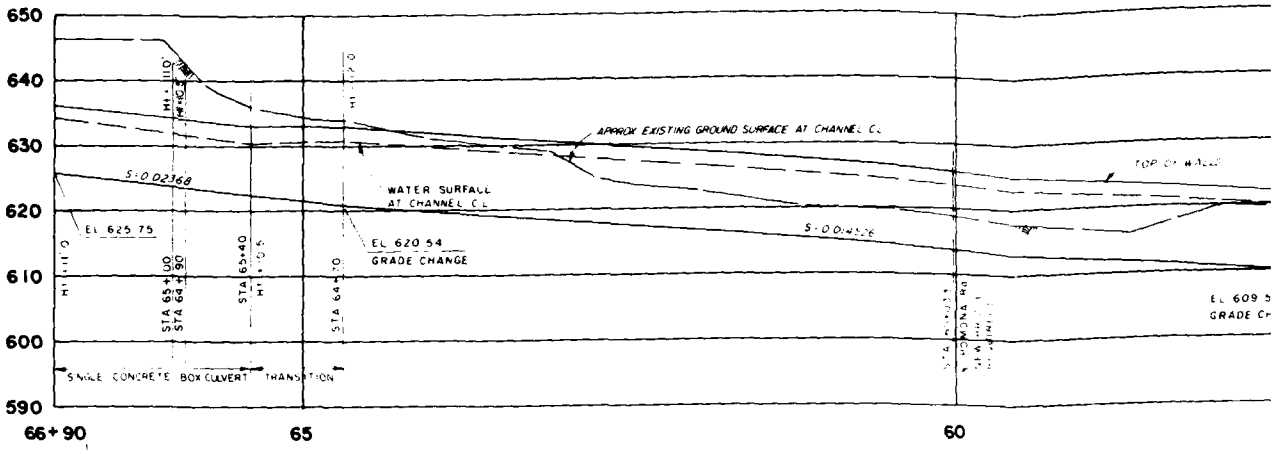
NOTES
1 SEE PLATE 3 FOR LEGEND
2 SEE PLATES 17 AND 19 LOGS OF EXPLORATION

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

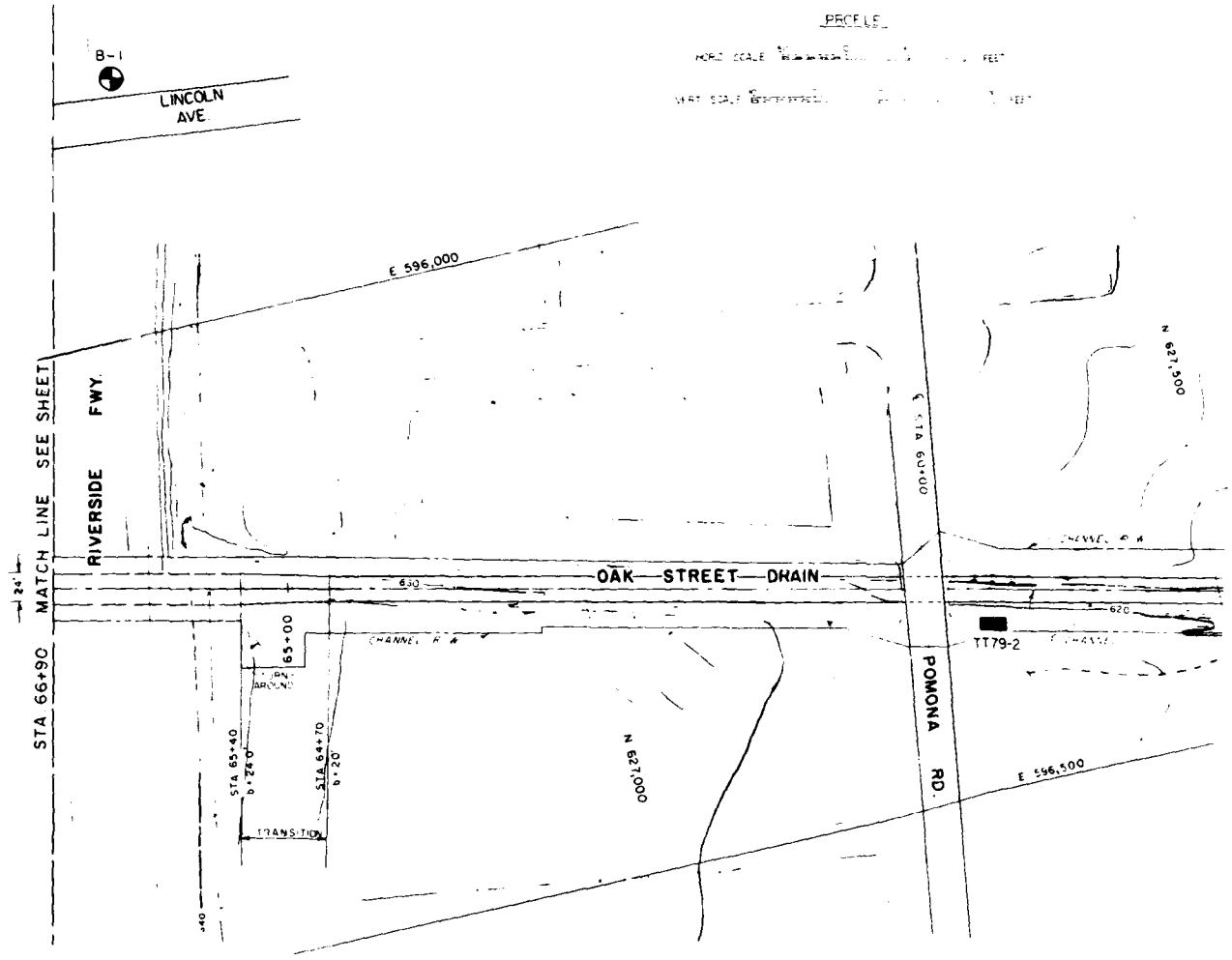
OAK STREET DRAIN

LOCATION OF EXPLORATION
STA 79+50 TO STA 66+90

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

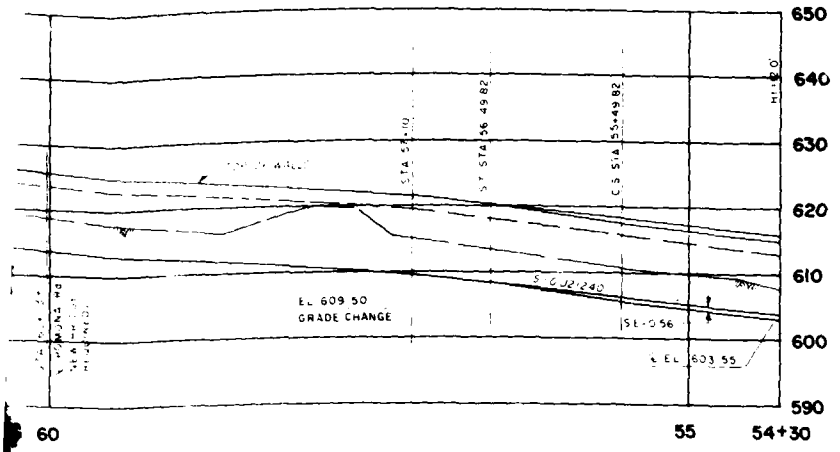


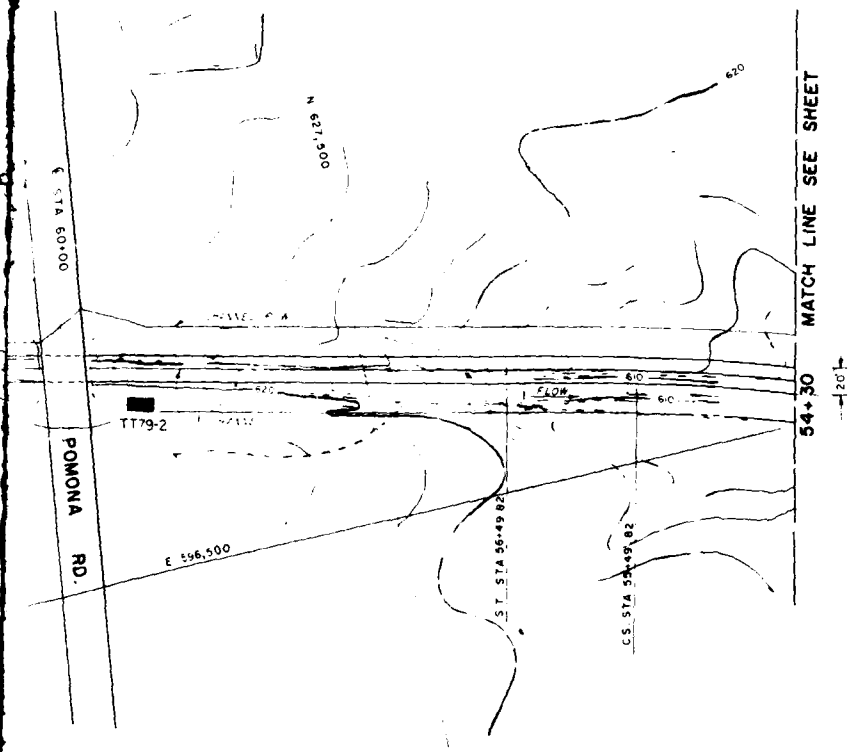
PROFILE

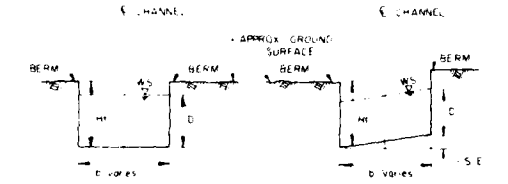


PLAN

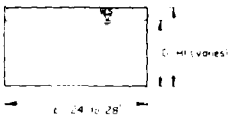
HYDRAULIC ELEMENTS									
STA. TO STA.		SECTION	SLOPE	Q	Dc	n=0.014			
						DA	VA	DA	VA
66+90	65+40	Box	.023682	7100	14.0	8.5	36.1	8.2	37.6
65+40	64+70	Trans	.023682	7100	Varies	8.2	37.6	10.0	36.5
64+70	57+10	20' Rect.	.014526	7100	15.8	10.0	36.5	10.0	36.7
57+10	54+30	20' Rect.	.02124	7100	15.8	10.0	36.7	9.6	38.5







OPEN SECTION ON TANGENT OPEN SECTION ON CURVE



BOX SECTION

TYPICAL SECTIONS

NOTES

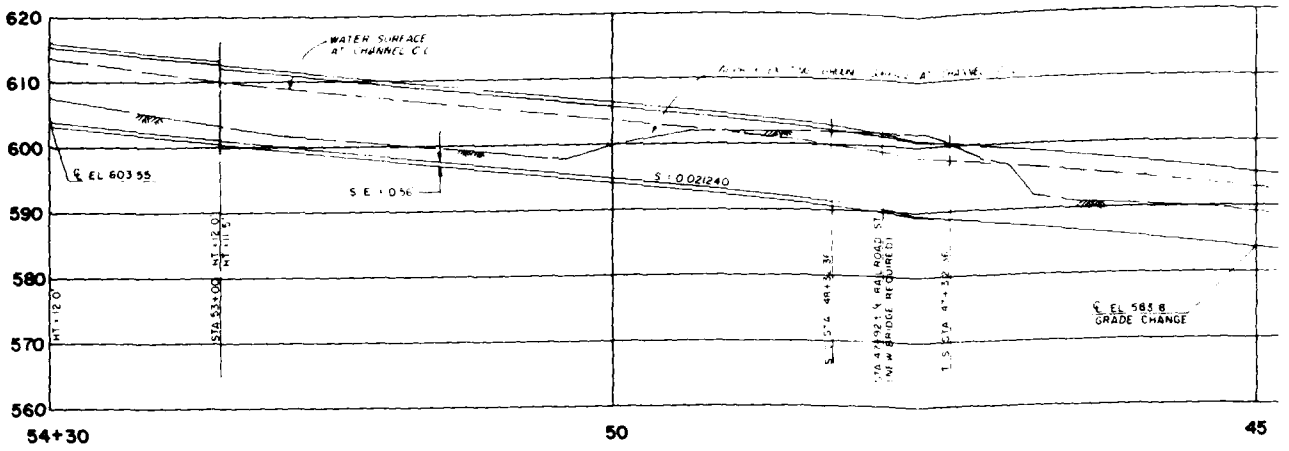
1. SEE PLATE 3 FOR LEGEND.
2. SEE PLATES 17 AND 19 FOR LOGS OF EXPLORATION

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

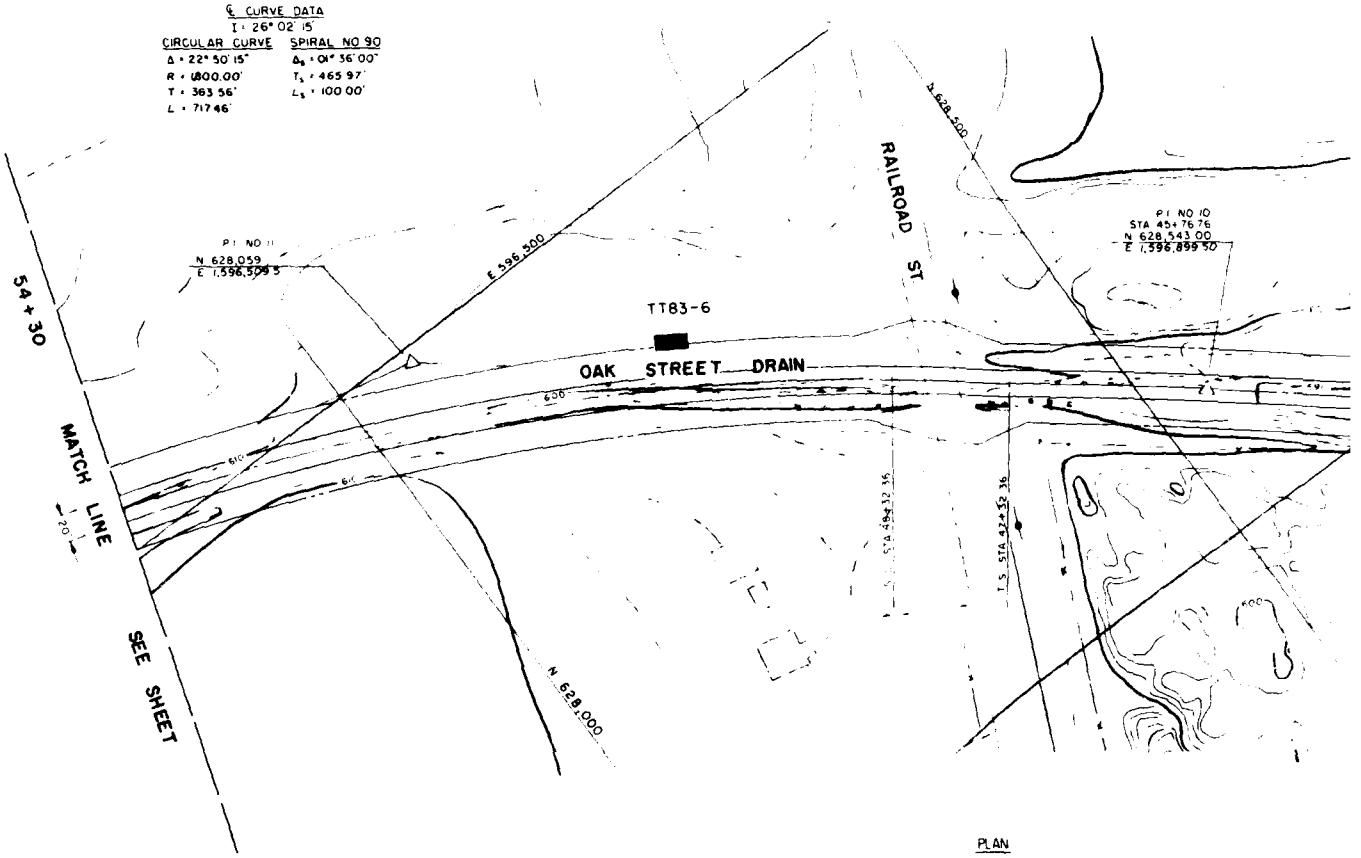
LOCATION OF EXPLORATION
STA. 66+90 TO STA. 54+30

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



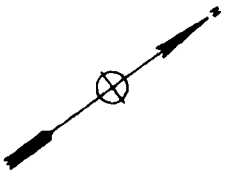
P.I. NO 11
℄ CURVE DATA
I = 26° 02' 15"

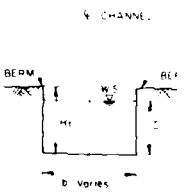
CIRCULAR CURVE	SPIRAL NO 90
Δ = 22° 50' 15"	Δ_s = 01° 36' 00"
R = 1800.00'	T_s = 465.97'
T = 363.56'	L_s = 100.00'
L = 717.46'	



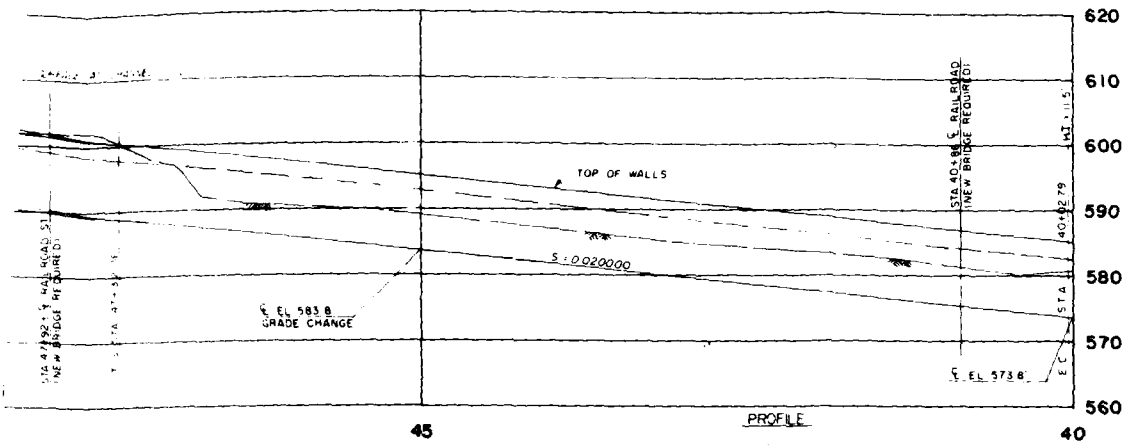
PLAN

HYDRAULIC ELEMENTS									
STA TO STA		SECTION	SLOPE	Q	Dc	n = 0.014			
						Da	Va	Da	Va
54+30	45+00	20' Rect	.021240	7100	15.8	9.6	38.5	9.1	41.3
45+00	40+00	20' Rect	.020000	7100	15.8	9.1	41.3	9.1	41.3





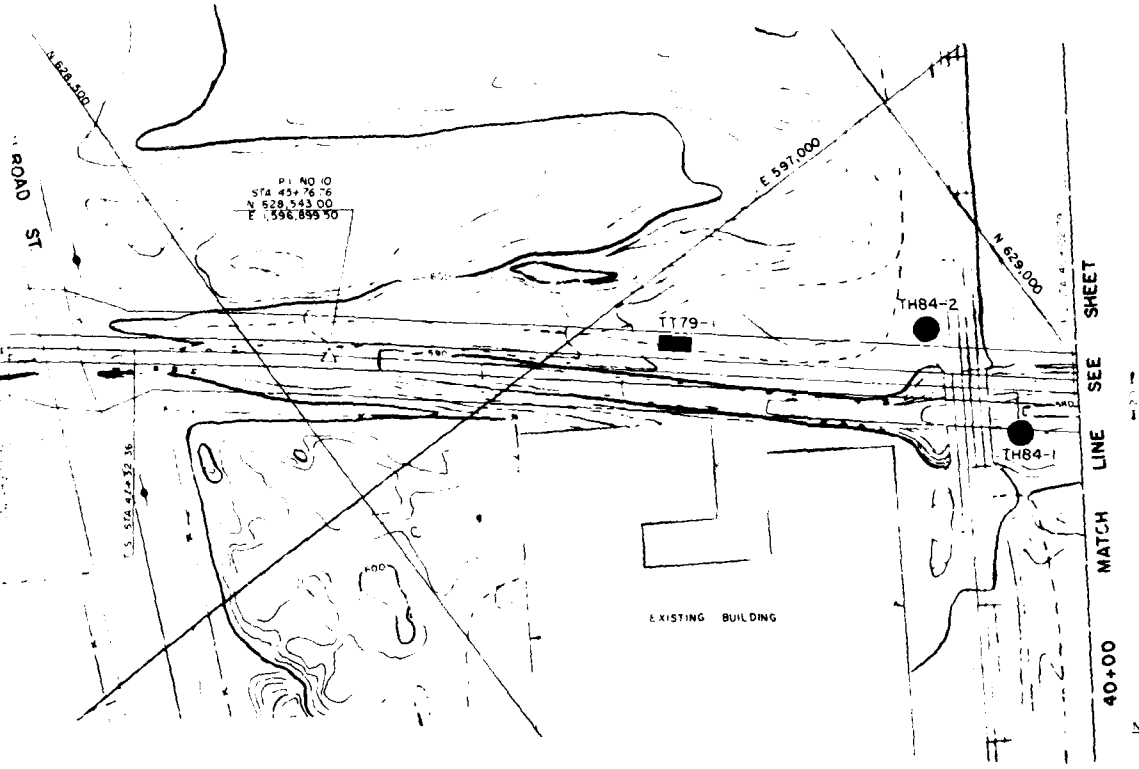
SECTION ON TANGEN



PROFILE

HORIZ SCALE 0 50 100 FEET

VERT SCALE 0 5 10 FEET

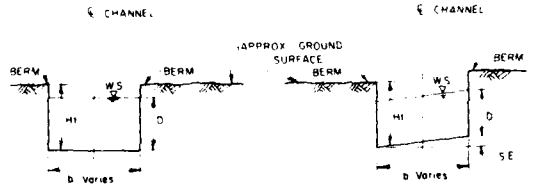


NOTES

1 SEE PLATE 3 FOR LEGEND

2 SEE PLATES 17 AND 18 FOR LOGS OF EXPLORATION

PLAN



SECTION ON TANGENT

SECTION ON CURVE

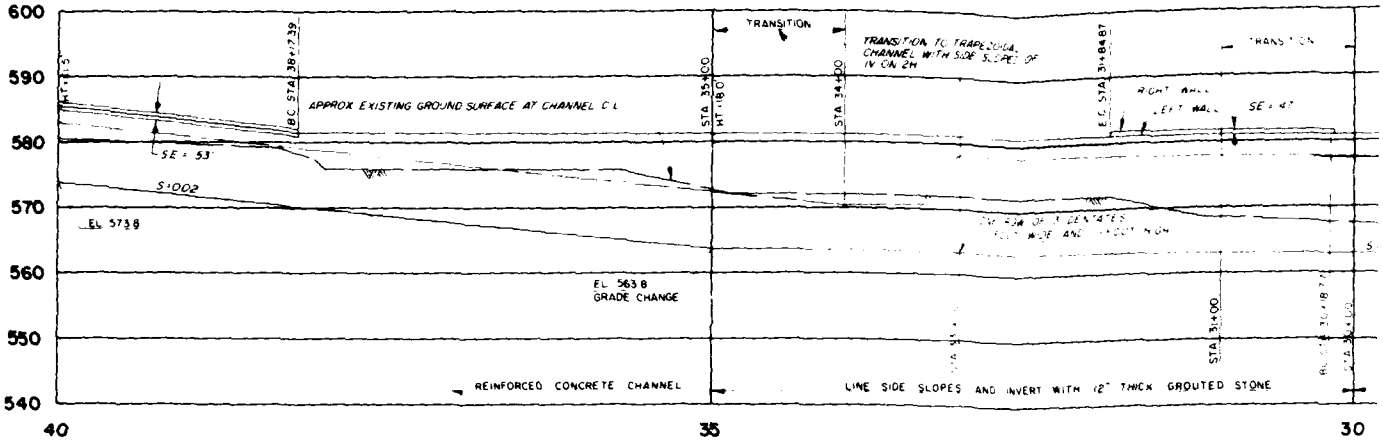
TYPICAL SECTIONS
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOCATION OF EXPLORATION
STA. 54+30 TO STA. 40+00

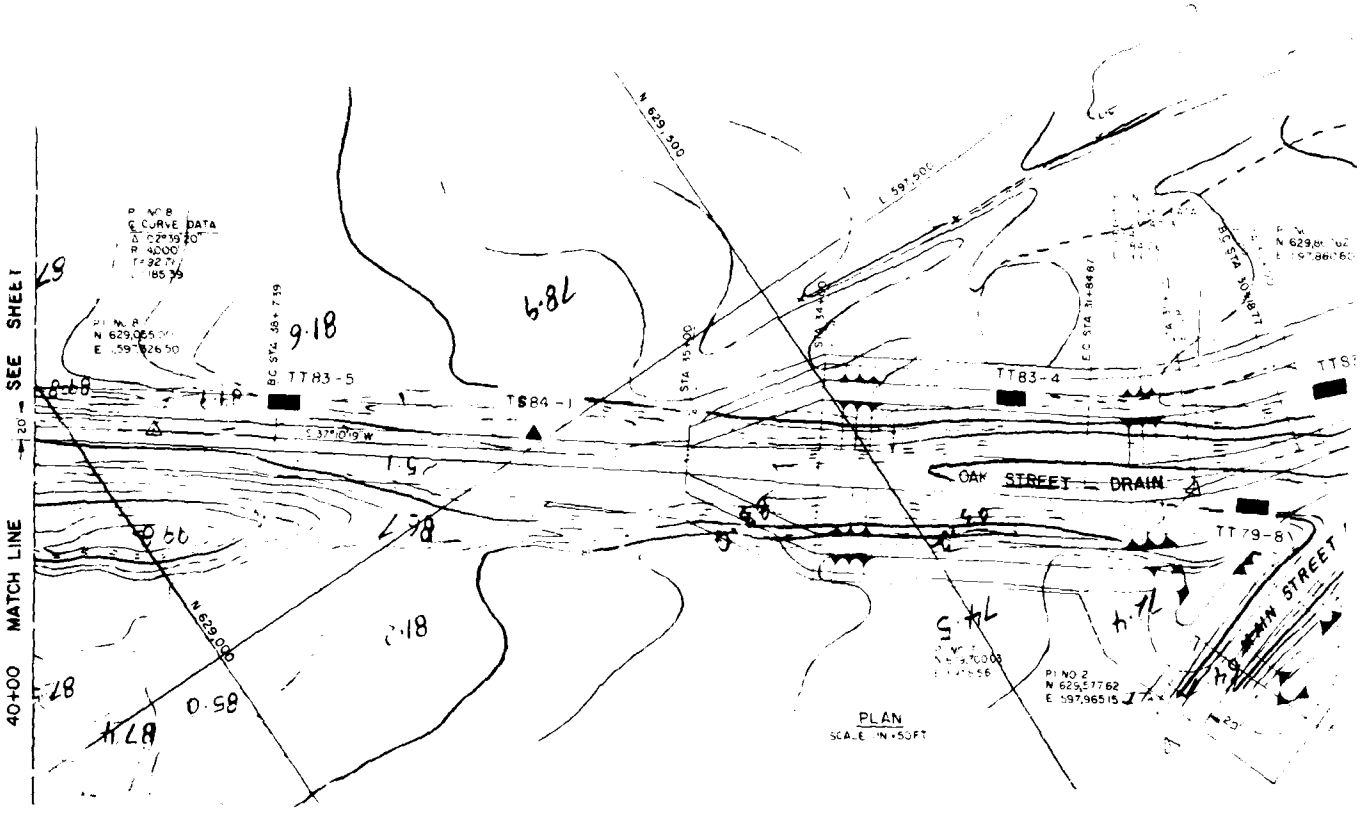
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



PROFILE

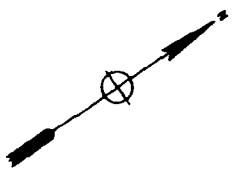
HORIZ SCALE 0 50 100 FEET

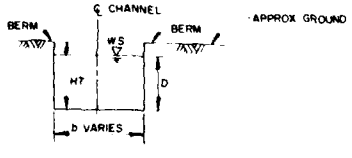
VERT SCALE 0 5 10 20 30 FEET



PLAN

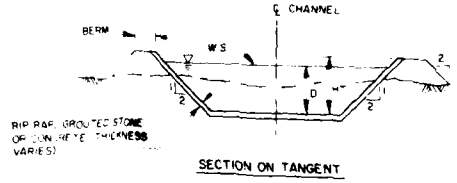
SCALE IN = 50FT





RECTANGULAR SECTION

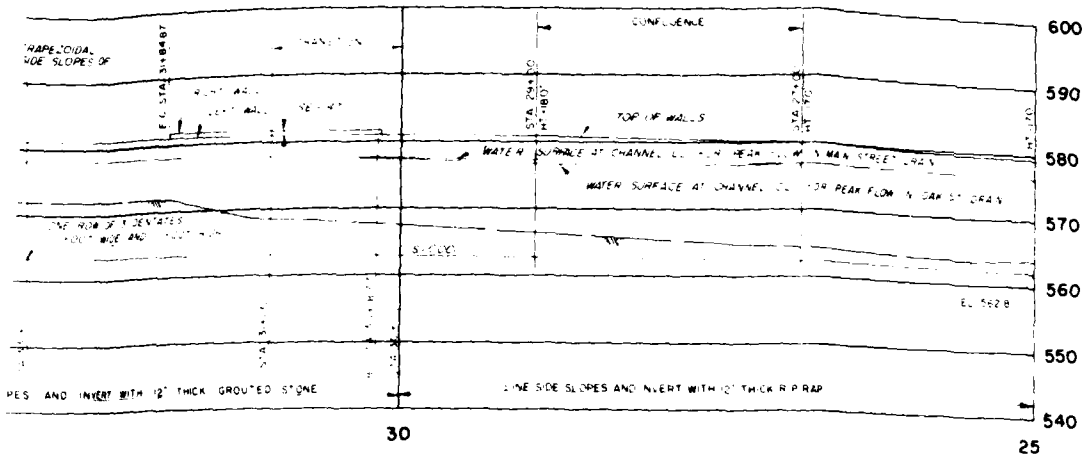
NOT TO SCALE



SECTION ON TANGENT

TYPICAL TI

SAFETY PAYS



PROFILE

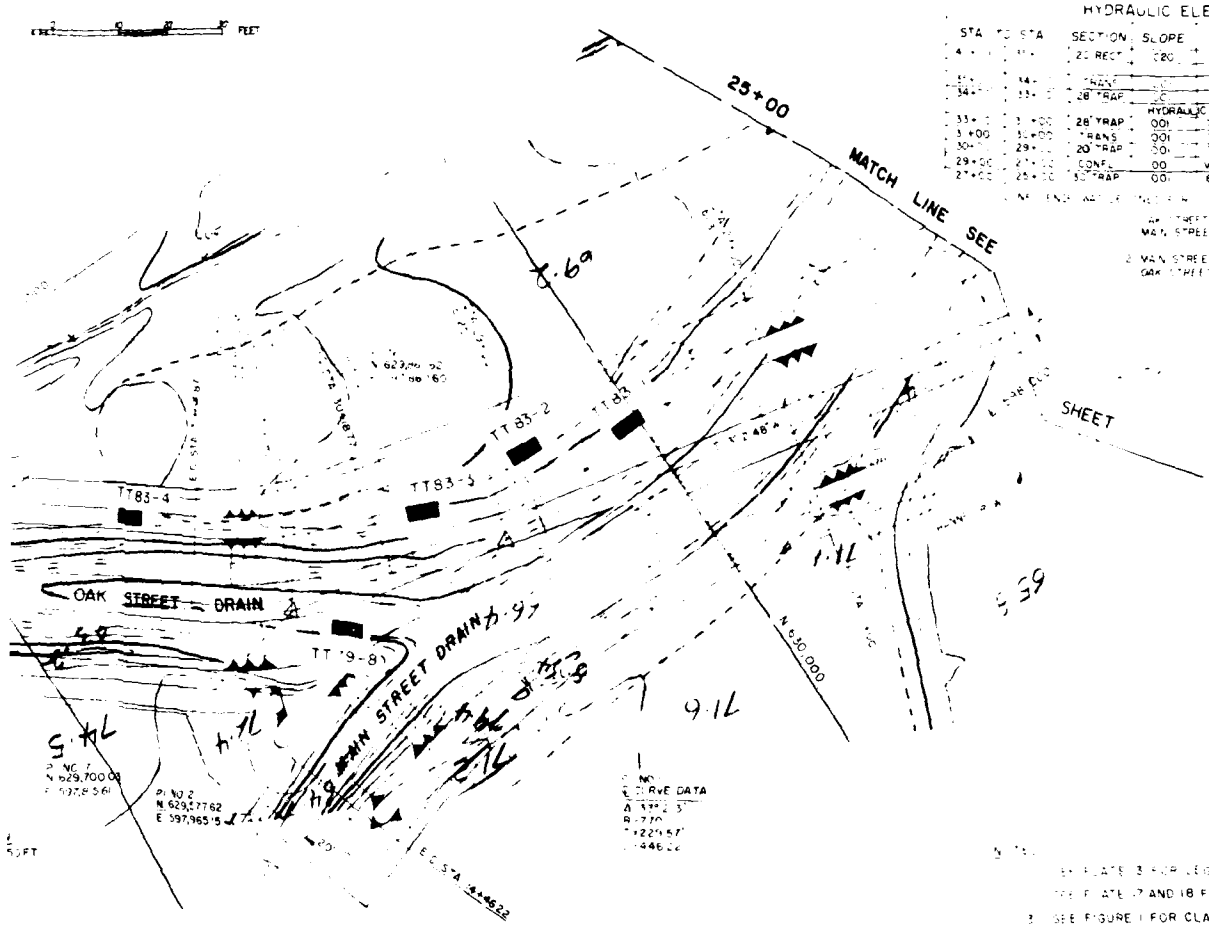
0 30 60 FEET

0 20 40 FEET

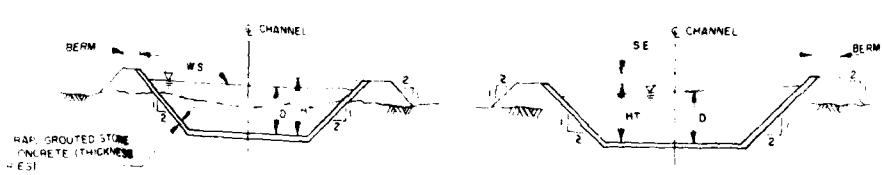
HYDRAULIC ELEMENTS

STA	TO STA	SECTION	SLOPE	Q	Dc	n=0.014			
						CA	vA	CA	vA
4+	9+	22' RECT	CRIT	7,100	5.8	9	41.3	9	41.3
9+	14+	TRANS		7,100	VARIES	9	41.3	55	365
14+	33+	28' TRAP	.00	7,100	9.9	55	365	62	298
		HYDRAULIC JUMP AT STATION							
33+	3+00	28' TRAP	.001	7,100	9.9	150	82	149	83
3+00	5+00	TRANS	.001	7,100	VARIES	49	83	45	62
30+	29+	20' TRAP	.001	7,100	8.61	145	62	145	62
29+00	27+	CONFL	.00	VARIES	VARIES	145	62	39	99
27+00	25+00	30' TRAP	.001	8,000	10.3	139	99	135	104

1. AT OAK STREET DRAIN PEAK Q = 7,100 CFS
   MAIN STREET DRAIN PEAK Q = 1,000 CFS
2. MAIN STREET DRAIN PEAK Q = 2900 CFS
   OAK STREET DRAIN PEAK Q = 3400 CFS



1. SEE PLATE 3 FOR LEGEND
2. SEE PLATE 17 AND 18 FOR LOGS OF EXPLORATION
3. SEE FIGURE 1 FOR CLASSIFICATION OF TS84-1



SECTION ON TANGENT

SECTION ON CURVE

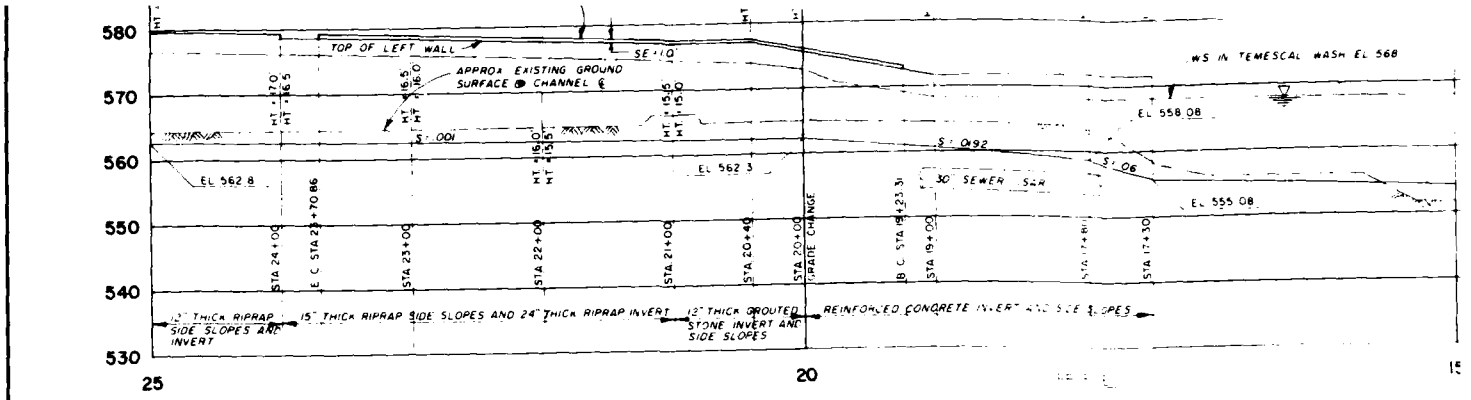
TYPICAL TRAPEZOIDAL SECTIONS
NOT TO SCALE

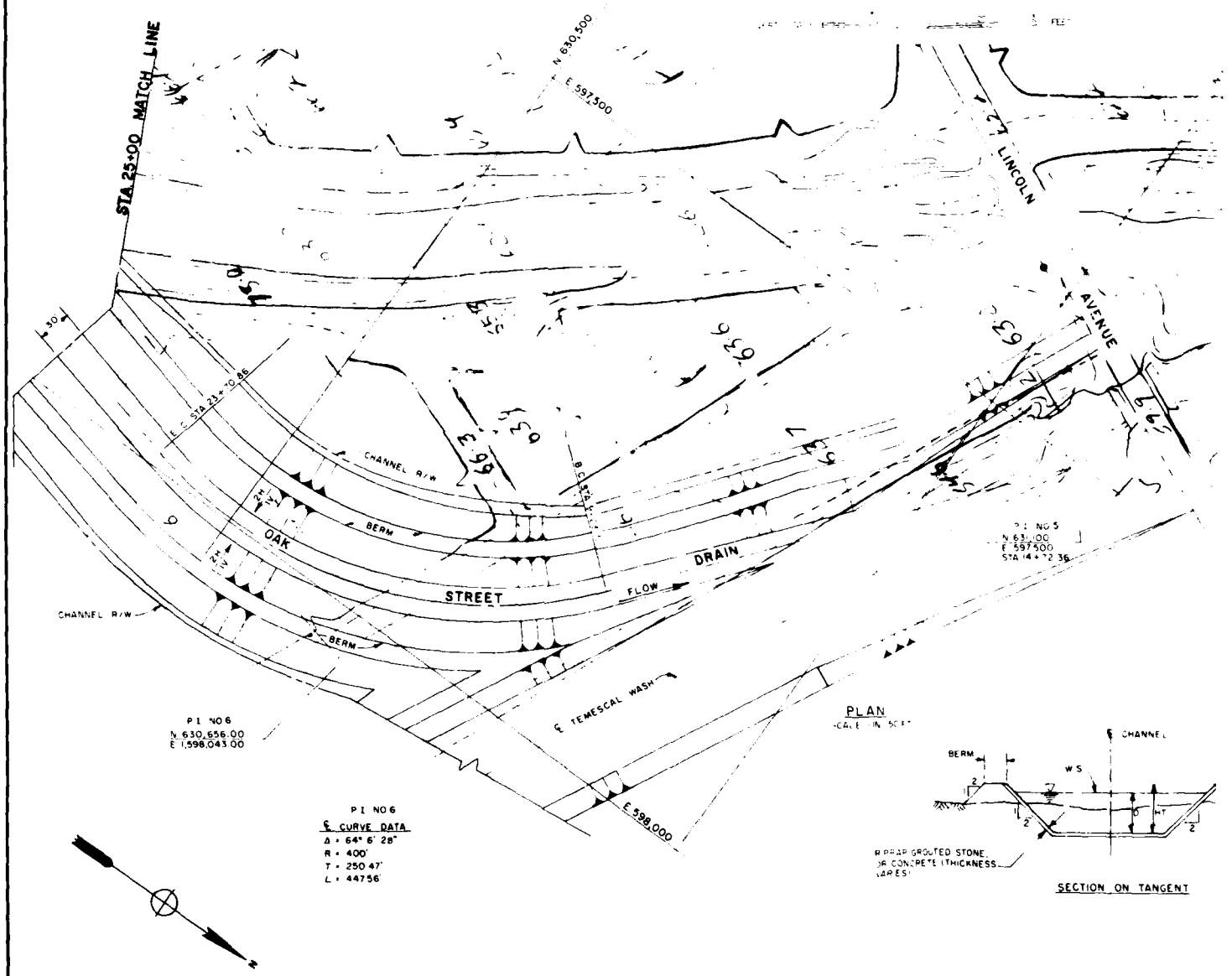
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

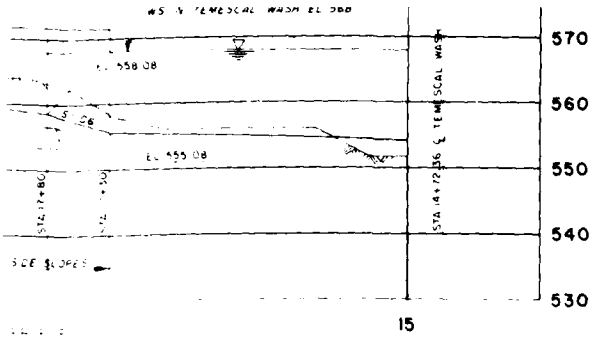
LOCATION OF EXPLORATION
STA 40+00 TO STA 25+00

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

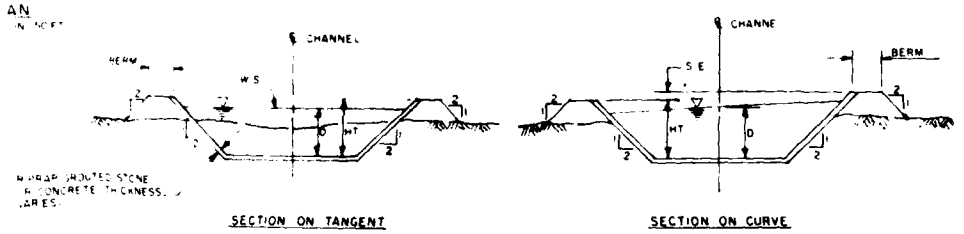

580
570
560
550
540
530
TOP OF LEFT WALL
APPROX EXISTING GROUND SURFACE @ CHANNEL ℄
WS IN TEMESCAL WASH EL 568
EL 558.08
EL 562.8
EL 562.3
EL 555.08
30" SEWER S&R
STA 24+00
STA 23+70.86
STA 23+00
STA 22+00
STA 21+00
STA 20+40
STA 20+00
GRADE CHANGE
STA 19+23.31
STA 19+00
STA 17+30
12" THICK RIPRAP SIDE SLOPES AND INVERT
15" THICK RIPRAP SIDE SLOPES AND 24" THICK RIPRAP INVERT
12" THICK GROUTED STONE INVERT AND SIDE SLOPES
REINFORCED CONCRETE INVERT AND SIDE SLOPES
25
20


STA 25+00 MATCH LINE
N 630,500
E 597,500
LINCOLN
AVENUE
30'
℄ STA 23+70.86
CHANNEL R/W
BERM
OAK
STREET
DRAIN
FLOW
CHANNEL R/W
BERM
P I NO 5
N 631,100
E 597,500
STA 14+72.36
℄ TEMESCAL WASH
E 598,000
P I NO 6
N 630,656.00
E 1,598,043.00
P I NO 6
℄ CURVE DATA
Δ = 64° 6' 28"
R = 400'
T = 250.47'
L = 447.56'
PLAN
SCALE IN SCF
℄ CHANNEL
BERM
W S
HT
RIPRAP GROUTED STONE OR CONCRETE (THICKNESS VARIES)
SECTION ON TANGENT

SAFETY PAYS



HYDRAULIC ELEMENTS									
STA TO STA		SECTION	SLOPE	Q	Dc	n = .030			
						DA	VA	DA	VA
25+00	20+00	30°TRAP	.001	8,000	10.3	3.5	10.4	10.3	15.3
					CONCRETE	n = .014			
20+00	17+80	30°TRAP	.0192	8,000	10.3	10.3	15.3	7.1	25.5
17+80	17+30	30°TRAP	.060	8,000	10.3	7.1	25.5	6.5	29.4



SECTION ON TANGENT

SECTION ON CURVE

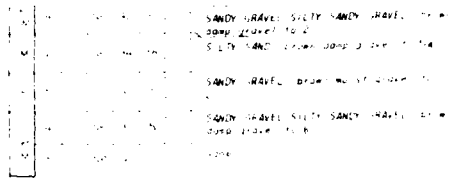
TYPICAL SECTION
NOT TO SCALE

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM

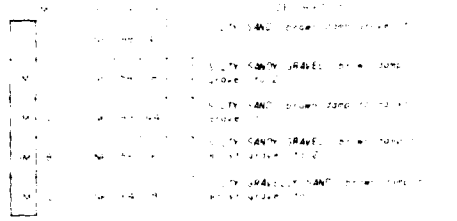
OAK STREET DRAIN

LOCATION OF EXPLORATION
STA. 25+00 TO STA 14+72.36

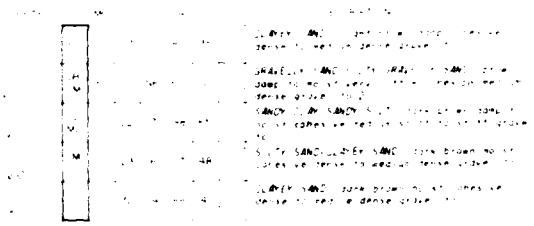
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



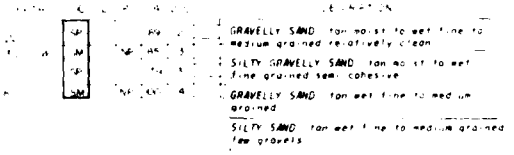
TT 79-3

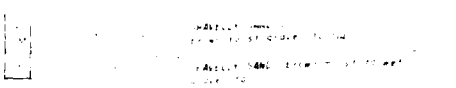


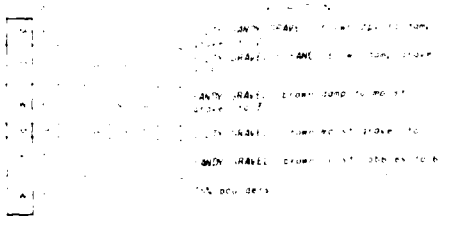
TT 79-6



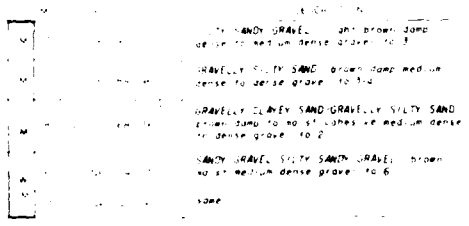
TT 83-1



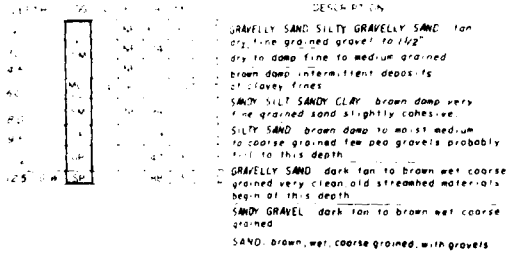




TT 79-7



TT 83-2



UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS More than half of material is larger than no 200 sieve size	GRAVELS More than half of coarse fraction is larger than no 4 sieve size	Clean gravels	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than no 4 sieve size	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sands, little or no fines
		Sands with fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half of material is smaller than no 200 sieve size	SILTS AND CLAYS	Low liquid limit	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays
			OL	Organic silts and organic silty clays of low plasticity
		High liquid limit	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity
			OH	Organic clays of medium to high plasticity organic silts
Highly organic soils			Pt	Peat and other highly organic soils

NOTES:

1. Boundary Classification: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GW-GC, well-graded gravel-sand mixture with clay binder.
2. All sieve sizes on this chart are U.S. Standard.
3. The terms "silt" and "clay" are used respectively to distinguish materials exhibiting lower plasticity from those with higher plasticity. The minus no. 200 sieve material is silt if the liquid limit and plasticity index plot below the "A" line on the plasticity chart (Table VI, Military Standard 619B) and is clay if the liquid limit and plasticity index plot above the "A" line on the chart.
4. The Soil Classification System is based on the American Society for Testing and Materials (ASTM):
   a. (ASTM) D2487, Standard Test Method for Classification of Soils for Engineering Purposes.
   b. (ASTM) D2488, Standard Recommended Practice for Description of Soils (Visual-Manual Procedure).

TT 79-7

TT 79-8

TT 83-2

TT 83-3

LEGEND

MC	FIELD MOISTURE CONTENT IN PERCENT OF DRY WEIGHT.
LL	LIQUID LIMIT
PI	PLASTICITY INDEX (LIQUID LIMIT MINUS PLASTIC LIMIT)
NP	NONPLASTIC
-4	PERCENT OF MATERIAL BY WEIGHT PASSING NO 4 SIEVE.
-200	PERCENT OF MATERIAL BY WEIGHT PASSING NO 200 SIEVE.
▽	DEPTH TO WATER
TT79-1	YEAR AND NUMBER OF TEST TRENCH, U.S. ARMY CORPS OF ENGINEERS
TH84-1	YEAR AND NUMBER OF TEST HOLE, U.S. ARMY CORPS OF ENGINEERS.
BORING-1	NUMBER OF BORING, CONVERSE DAVIS DIXON GEOTECHNICAL CONSULTANTS.
B-1	NUMBER OF BORING, CALTRANS.

NOTE:

SEE PLATES 7 AND 8, 12 THRU 15 FOR LOCATIONS OF TEST TRENCHES.

VERT SCALE 5 0 5 10 FT

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER, CALIFORNIA

PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOGS OF EXPLORATION CORPS OF ENGINEERS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

APPENDIX B

PLATE

TT 83-4

DEPTH	LOG	LL	PI	-4	-200	DESCRIPTION
1.0'	GP			25	0	SANDY GRAVEL, tan, damp, fine to coarse grained sand
2.0				30	2	moist to wet, coarse grained sand, perched water at 2.0'
	SM	31	8	97	49	SILTY SAND, tan, wet, fine grained
7.0						
8.0	SP			67	4	GRAVELLY SAND, gray brown, wet, medium to coarse grained

TT 83-5

DEPTH	LOG	LL	PI	-4	200	DESCRIPTION
1.0	SW			77	2	GRAVELLY SAND, tan dry loose some organics
3.0	GW			38		SANDY GRAVEL, tan slightly damp
	SP			57	3	GRAVELLY SAND, tan damp loose, fine to coarse grained
6.0	GP			47	4	SANDY GRAVEL, tan moist medium to fine grained sand
10.0						
11.0'		29	8	97	54	SANDY CLAY, brown moist
13.0	CL	32	10	100	70	moist to wet

TT 83-8

DEPTH	LOG	LL	PI	-4	-200	DESCRIPTION
	SP			53	2	GRAVELLY SAND, gray brown, dry to damp
4.0	SW			74	2	brown, damp, coarse grained with pea gravels
6.5	SP/SM					
7.0	SM		NP	61	8	GRAVELLY SAND/SILTY GRAVELLY SAND, brown, damp, medium to fine grained
9.0	SM/SC	23	5	80	34	GRAVELLY SILTY SAND/GRAVELLY CLAYEY SAND, brown, damp, fine to medium grained, some cohesion, some gravels
	SC	25	8	75	40	
13.0						
14.0	GC	26	9	53	17	GRAVELLY CLAYEY SAND, reddish brown, damp, fine grained, cohesive, some gravels
15.0	SW/SM		NP	68	9	CLAYEY SANDY GRAVEL, reddish brown, damp some cohesion, medium to fine grained sand
	SP/SM					
	SM		NP	61	9	GRAVELLY SAND/SILTY GRAVELLY SAND, reddish brown, damp, coarse to medium grained, some gravels
18.5						yellowish reddish brown, increasing amounts of gravel

TT 83-9

DEPTH	LOG	LL	PI	-4	200	DESCRIPTION
	SP/SM		NP	65	10	GRAVELLY SAND SILTY GRAVELLY SAND, brown damp medium to fine grained
5.5	ML	22	4	87	54	SANDY SILT, red brown damp fine grained sand
9.0	SM		NP	61	13	SILTY GRAVELLY SAND, red brown damp, coarse to fine grained
14.5	SM/SC	24	7	78	43	GRAVELLY SILTY SAND GRAVELLY CLAYEY SAND red brown damp fine grained
15						

TH 84-1

DEPTH	LOG	-4	-200	N*	DESCRIPTION
	SM			15	SILTY GRAVELLY SAND, brown tan moist, loose, some gravels to 1"
5.0'	SP/SM	58	12	28	GRAVELLY SAND/SILTY GRAVELLY SAND, brown moist, some cohesion, gravels up to 1"
10.0'					
12.0'		66	16	18	SILTY GRAVELLY SAND, red brown, moist, with some gravels
13.0'	SM	65	15	27	brown, some cohesion, with gravels
18.0'		61	13	16	dark brown, some cohesion, with gravels to 1 1/2"
	SP/SM	56	11	49	GRAVELLY SAND/SILTY GRAVELLY SAND, dark brown, moist, some cohesion
23.0'					
	ML	99	53	14	SANDY SILT, dark brown, moist, cohesive
28.0'					
30.0'	SW/SM	89	5	27	SAND/SILTY SAND, gray, moist, coarse grained
33.0'		64	9	33	GRAVELLY SAND/SILTY GRAVELLY SAND, gray, some cohesive material, coarse grained, many gravels
	SP/SM	67	6	39	gray brown, wet, dense
37.0'					
40.0'	SW/SM	82	7	37	numerous gravels to 1"

TH 84-2

DEPTH	LOG	-4	-200	N*	DESCRIPTION
	SP/SM	64	10	64	GRAVELLY SAND/SILTY GRAVELLY SAND, brown moist very dense some cohesion, coarse grained
5.0'		75	7		some
10.0'	SW/SM			22	
		76	11		some
13.0'				22	
		65	7		some
16.0'	SP/SM			65	
		66	9		some
20.0'				13	
	SW/SM	69	9	65	very dense
23.0'					
	SP/SM	63	8	9	some
26.0'					
28.0'		67	5	33	gray tan dense gravels to 1/2"
	SW/SM	73	7		tan dense some gravel to 1/2"
33.0'				36	
36.0'	GP/GM	53	7	62	SANDY GRAVEL/SILTY SANDY GRAVEL, tan, moist, dense, gravels to 1"
38.0'	SP/SM	77	8	65	GRAVELLY SAND/SILTY GRAVELLY SAND, tan, moist, dense, some cohesion, some gravels to 1 1/2"
	SW/SP	86	8	59	gray.
42.0'					

TT 83-6

DEPTH	LOG	PI	4	200	DESCRIPTION
	SP			52	GRAVELLY SAND, gray tan dry to damp, coarse grained
4.0					
6.5	GW			43	3 SANDY GRAVEL, damp to moist
7.0	SW			47	3 GRAVELLY SAND, gray brown, damp to moist
8.5	SM/SC	25	6	73	31 GRAVELLY SILTY SAND/GRAVELLY CLAYEY SAND, dark tan, damp to moist fine grained
10.0	SP			55	5 GRAVELLY SAND, tan, damp to moist coarse to medium grained sand
12.0	SM	22	3	84	37 GRAVELLY SILTY SAND, dark tan, fine grained
	GP-GM			45	6 SANDY GRAVEL/SILTY SANDY GRAVEL, dark tan damp to moist
14.5	ML	24	3	100	58 SANDY SILT, tan, damp to moist, fine grained sand

TT 83-7

DEPTH	LOG	PI	4	200	DESCRIPTION
2.5	SM/SC	26	5	69	24 SILTY GRAVELLY SAND/CLAYEY GRAVELLY SAND, brown, dry to damp, fine grained some cobbles possibly fill
	SM	22	2	92	47 SILTY SAND, brown damp fine grained
8.0					
9.0	SM/SC	24	6	73	38 GRAVELLY SILTY SAND/GRAVELLY CLAYEY SAND, brown, damp, fine grained, some cobbles
11.5	GW-GM	NP		33	10 SANDY GRAVEL/SILTY SANDY GRAVEL, brown dry to damp, fine grained some cobbles boulders with increasing depth
13.5	GP-GM	NP		30	8 cobbles and gravels greater than 50%, no boulders
15.0	GC	31	28	36	16 SANDY GRAVEL/CLAYEY SANDY GRAVEL, brown damp fine grained sands

TT 83-10

DEPTH	LOG	PI	4	200	DESCRIPTION
				46	SANDY GRAVEL, brown damp medium to coarse grained sand
4.5					SILTY GRAVELLY SAND, brown damp, medium to coarse grained
	SM	NP		6	

TT 83-11

DEPTH	LOG	PI	4	200	DESCRIPTION
					GRAVELLY SAND, brown damp, medium to coarse grained
				8	4

NOTES:

1. SEE PLATE 17 FOR LEGEND AND CLASSIFICATION SYSTEM.
2. SEE PLATES 3 THRU 6, 8, 14 AND 15 FOR LOCATION OF TEST TRENCHES AND TEST HOLES.

N = NUMBER OF BLOWS OF A 140-POUND DROP HAMMER FALLING 30 INCHES REQUIRED TO DRIVE A SAMPLING SPOON ONE FOOT. OUTSIDE DIAMETER OF SPOON IS 2.5 INCHES. INSIDE DIAMETER IS 2.0 INCHES.

VERT SCALE 5 0 5 10 FT

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER, CALIFORNIA

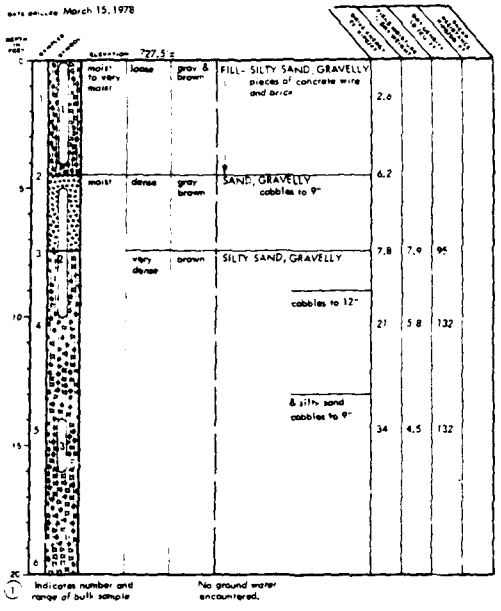
PHASE II GENERAL DESIGN MEMORANDUM

OAK STREET DRAIN

LOGS OF EXPLORATION CORPS OF ENGINEERS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

BORING NO. 1



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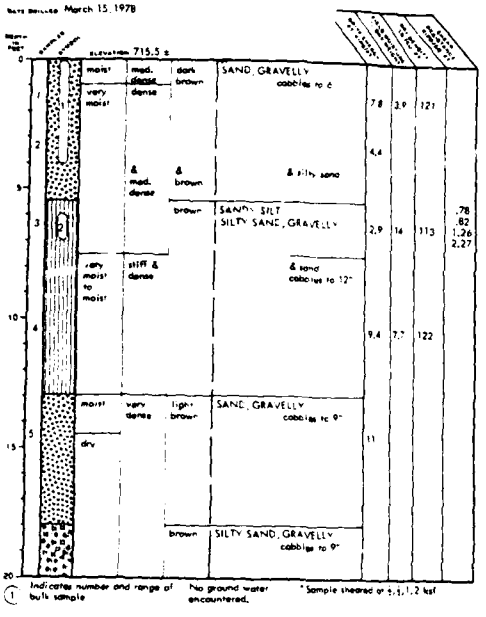

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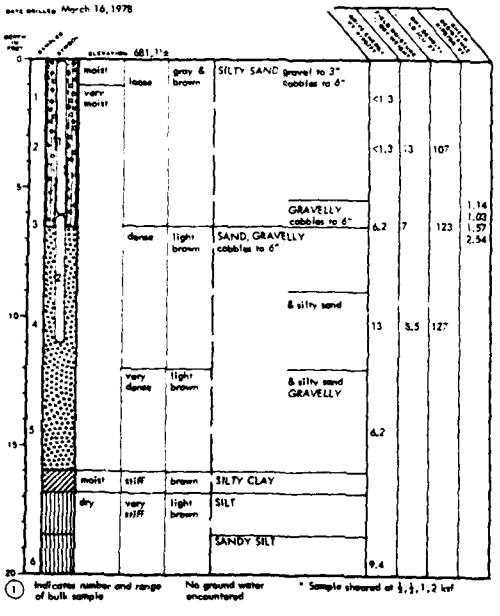
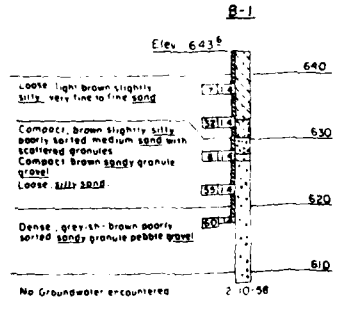
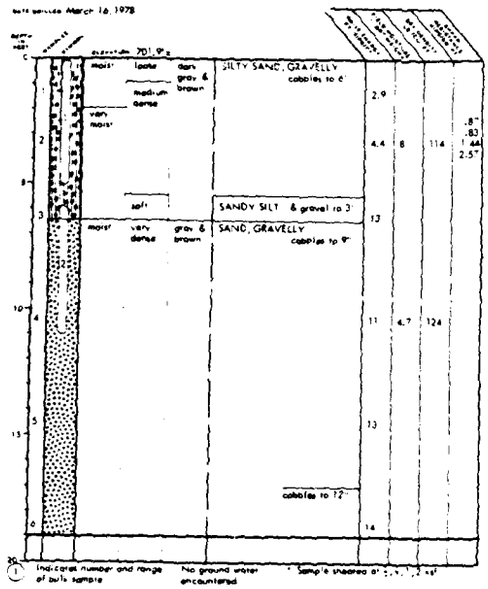




BORING NO. 3



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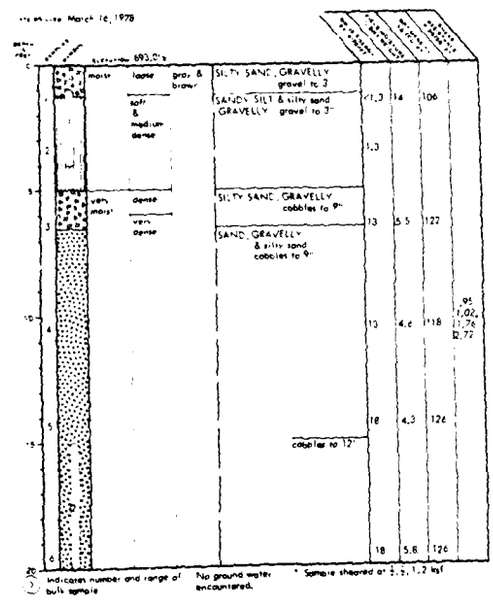
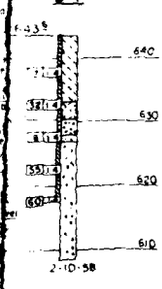
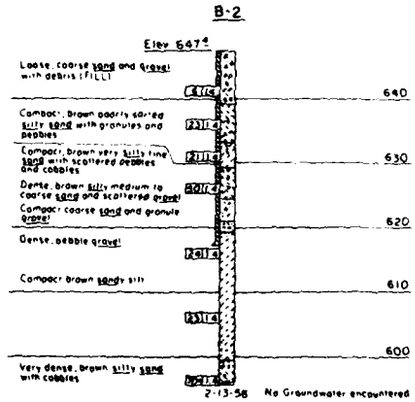


B-1



B-2



NOTES:

1. SEE PLATE 17 FOR LEGEND AND CLASSIFICATION SYSTEM.
2. SEE PLATES 10 THRU 13 FOR LOCATION OF BORINGS.

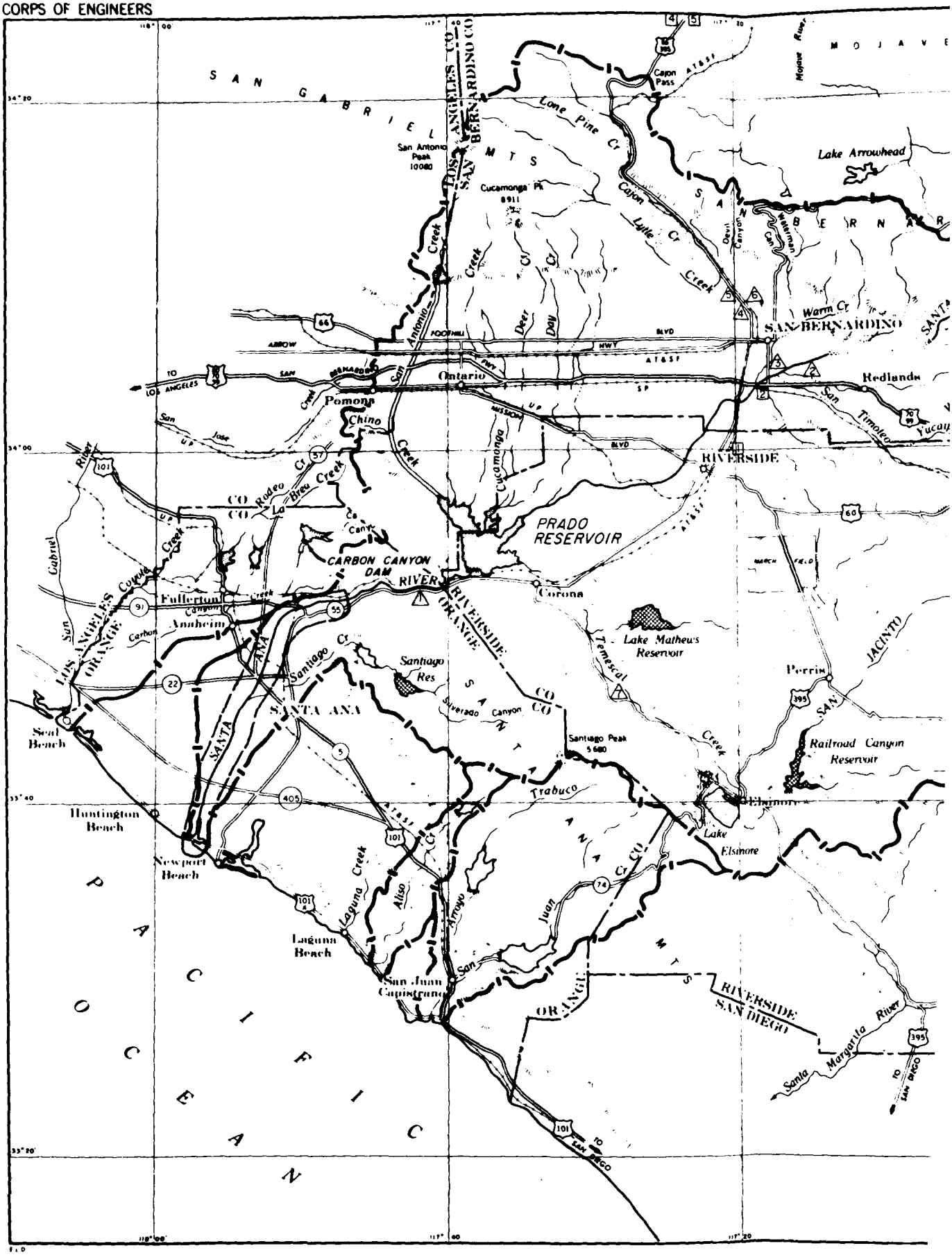
SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

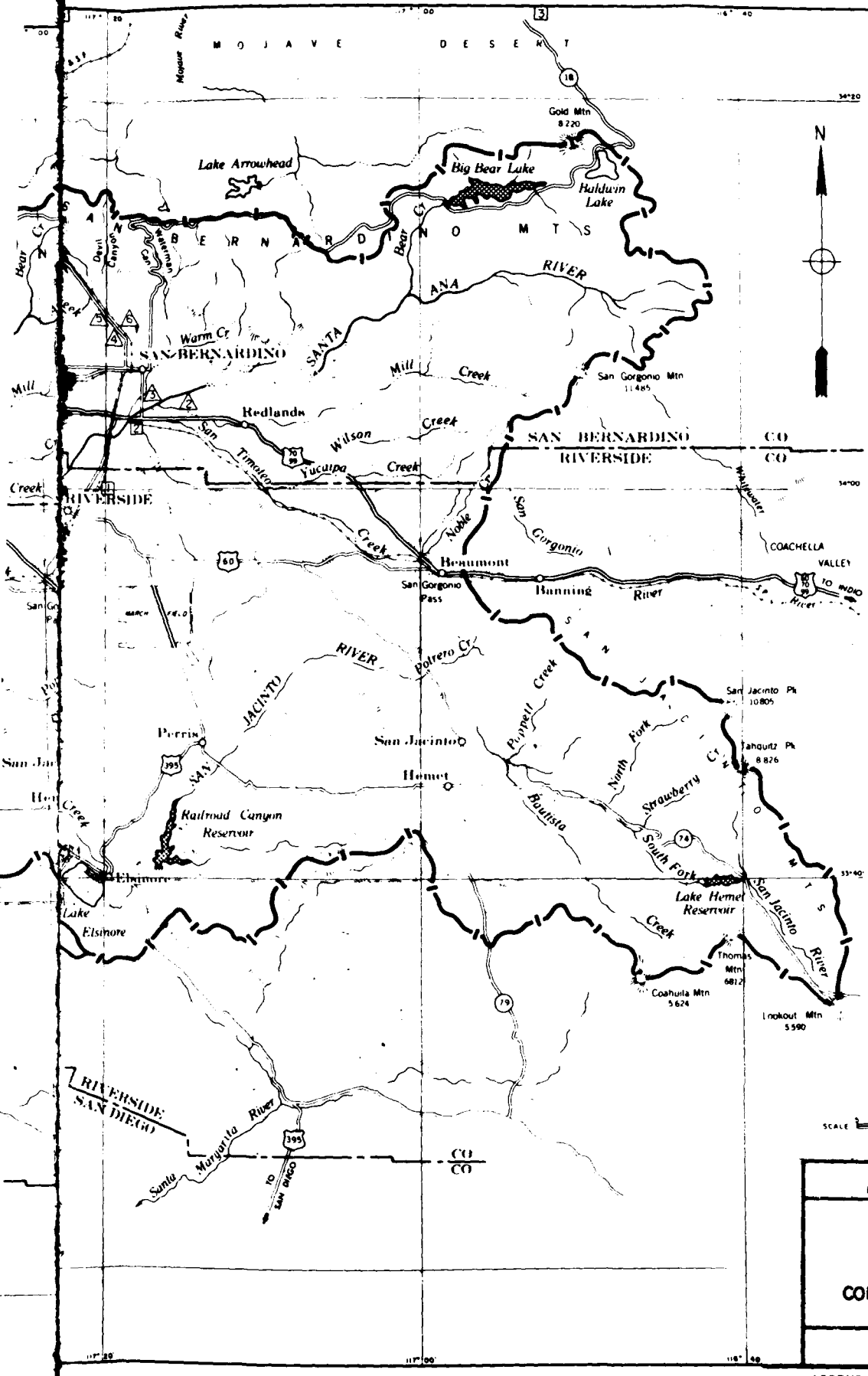
SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN

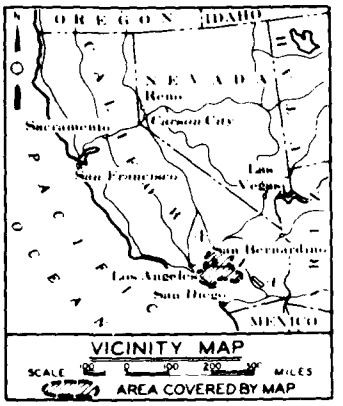
LOGS OF EXPLORATION SUPPLEMENTAL

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

CORPS OF ENGINEERS







AGGREGATE SOURCES

1. OWL ROCK PRODUCTS, GYPSUM CANYON
2. TRI-CITY ROCK CO, REDLANDS
3. FOURTH ST ROCK CRUSHER, SAN BERNARDINO
4. TRIANGLE ROCK PRODUCTS, SAN BERNARDINO
5. OWL SERVICE ROCK CO, LYTLE CREEK
6. LYTLE CREEK ROCK PRODUCTS, LYTLE CREEK
7. CHANDLER SAND AND GRAVEL, CORONA*

* NOT TESTED

CEMENT SOURCES

[1] RIVERSIDE PORTLAND CEMENT CO, CRESTMORE
[2] CALIFORNIA PORTLAND CEMENT CO, COLTON
[3] PERMANENTE CEMENT CO, LUCERNE VALLEY
[4] RIVERSIDE PORTLAND CEMENT, CO, ORO GRANDE
[5] SOUTHWESTERN PORTLAND CEMENT, VICTOR

SCALE MILES

DATUM IS MEAN SEA LEVEL

SANTA ANA RIVER, CALIFORNIA
PHASE II GENERAL DESIGN MEMORANDUM
OAK STREET DRAIN

CONCRETE MATERIALS SOURCES

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SUPPLEMENTARY

INFORMATION

AD-A204 546

Errata

DESIGN MEMORANDUM NO. 1
PHASE II GDM ON THE SANTA ANA
RIVER MAINSTEM, INCLUDING SANTIAGO CREEK
DATED: AUGUST 1988

On November 15, 1988, the U.S. Army Corps of Engineers released, for agency and public review, the Congressionally authorized final General Design Memorandum (GDM) for the Santa Ana River Mainstem Project, including the Main Report and Supplemental Environmental Impact Statement, and accompanying volumes and technical appendixes. The Corps mailed copies of the final Phase II GDM to selected Federal, State, and local governmental agencies; elected officials within the project area: flood control districts; interest groups; and public libraries. Review of the final Phase II GDM by the agencies and the public generated comments which, in general, focused on the following concerns:

(a) Recreation trails along the Santa Ana River; (b) Aquatic habitat at Seven Oaks Dam; (c) Lower Santa Ana River sediment transport and potential beach degradation; (d) Esthetics and construction phasing for the Santiago Creek channel improvements; and (e) Flood threat and associated impacts to the Corona Airport within the Prado Dam. Inclosure 1 presents a synopsis of the U.S. Army Corps Engineers response to these concerns.

Following publication of the final Phase II GDM, several inconsistences were noted that require clarification of certain statements, and correction of typographical errors. The errata sheets (Inclosure 2) provide the revisions to be incorporated in the final Phase II GDM.

For additional information you may direct your inquiries to the following:

U.S. Army Corps of Engineers
P.O. Box 2711, L. A., CA 90053-2325
Attn: Mr. Dionicio Gonzales
Tel No. (213) 894-2713

Encls

Tadahiko Ono
for Colonel, Corps of Engineers
District Engineer

U.S. ARMY CORPS OF ENGINEERS
RESPONSES TO AGENCY AND PUBLIC REVIEW COMMENTS
ON
DESIGN MEMORANDUM NO. 1
PHASE II GENERAL DESIGN MEMORANDUM
ON THE SANTA ANA RIVER MAINSTEM, INCLUDING
SANTIAGO CREEK
DATED: AUGUST 1988

RECREATION TRAILS ALONG THE SANTA ANA RIVER

ISSUE - The Main Report and Supplemental Environmental Impact Statement indicated that the equestrian trails in several locations along the Santa Ana River would be a continuous paved surface. Comment was made that this would constitute an unacceptable conversion of use since the existing trails are unpaved.

RESPONSE - The Corps and Orange County, one of the sponsors, will be developing several alternative solutions in coordination with the National Park Service to resolve this issue. One solution would be to locate the trail along the toe of the levee, while a more promising one may be to use excess spoil material to widen the top of the levee within the existing rights-of-way. We anticipate that this issue can be successfully resolved.

AQUATIC HABITAT AT SEVEN OAKS DAM

ISSUE - Concern was for the need for additional mitigation measures to compensate for impacts on aquatic habitats at the Seven Oaks damsite.

RESPONSE - The recommended mitigation plan to compensate for impacts resulting from the Seven Oaks Dam portion of the project was evaluated, and project related impacts and achievable mitigation goals were defined. The evaluation indicated that the mitigation plan for Seven Oaks Dam will meet 14.5% of the mitigation goal for aquatic habitat. Following coordination with the various resource agencies, no mitigation options were found which would achieve 100% mitigation under current Corps policy on mitigation. The Corps agrees that the aquatic habitat is impacted and has identified the magnitude of the impact according to NEPA requirements. The Corps has considered all practicable mitigation options in fulfilling its 404(b)(1) requirements. The project has been determined to not be contrary to the public interest even though 100% mitigation of impacts is not achieved.

LOWER SANTA ANA RIVER - SEDIMENT TRANSPORT & BEACH DEGRADATION

ISSUE - Concern was for impacts of the project on coastal beaches and that the project does not assure commitments to mitigate for these adverse impacts.

RESPONSE - The concern was based on the statement in the SEIS, page V-57, paragraph 5-192, which stated that there would be a reduction in sediment available for beach replenishment as a result of the project. Upon close scrutiny of the aforementioned paragraph we find that the statements contained therein are erroneous and was inadvertently included in the SEIS. Volume 3, Lower Santa Ana River, presents results of the sediment transport analysis which indicates that there would be a net increase of 11,000 cubic yards of sediment per year available for beach replenishment with the project in place. Accordingly, the aforementioned paragraph in the SEIS will be revised to read as follows:

"Under existing channel conditions, large floods will breach levees causing flood flows and sediment to exit and deposit onto the Santa Ana River Flood Plain. With the project channel improvements, large flood flows (up to 190 year frequency) will remain in the channel, thus causing any sediment that would have been deposited in the floodplain to be deposited in the channel itself or conveyed to the ocean. With the Santa Ana River project in place, sand-sized sediment yield (average annual basis) is estimated to increase by 11,000 cubic yards."

The Corps has held several meetings with staff members of both the California Coastal Commission and the City of Newport Beach to resolve the issue of placement of compatible channel material on the beach. The discussions appear to be headed to a mutually acceptable agreement..

ESTHETICS AND CONSTRUCTION PHASING FOR THE SANTIAGO CREEK CHANNEL IMPROVEMENTS

ISSUE - The concern was raised regarding the channel design and construction phasing of Santiago Creek, and the associated esthetics impacts of the project.

RESPONSE - The design displayed in the report for the stabilization of Santiago Creek between the Santa Ana Freeway and the Santa Ana River reflects the minimum amount of construction required to reliably and economically protect the streambed and banks of the creek from erosion. This design was developed after carefully consideration of the desires of residents along the creek as expressed in numerous public involvement meetings, and as the result of detailed investigation of several alternatives. The Corps of Engineers cannot support any lesser level of improvement as being sufficiently reliable. If this reach of channel is not stabilized to the minimum level shown in the report, significant erosion of the stream banks with potentially disastrous damage to property immediately adjacent to the creek on both sides would occur during controlled design flood releases from the detention basin. If the reach of the Santiago Creek from the Santa Ana Freeway to the Santa Ana River is not sufficiently stabilized, the flood control project cannot be safely operated as designed. In regards to the construction phasing for Santiago Creek it is not advisable to construct the upstream flood control improvement prior to commencing

any construction downstream of the freeway because of the need to have the lower channel in place to operate the detention pits.

FLOOD THREAT TO THE CORONA AIRPORT WITHIN PRADO BASIN

ISSUE - Concerns were raised about the potential flood threat at the Corona Airport as a result of the Corps recommended modifications to Prado Dam.

RESPONSE - The Corps studies indicate that the recommended Prado modifications will enable us to make larger releases from Prado Dam, thus allowing faster drawdown of the flood control pool. Consequently, within the period of the current airport lease, the frequency and duration of flooding at the airport will be reduced with the recommended modification of Prado Dam. Should interests at the airport feel that a levee is imperative to protect the airport from frequent flooding while allowing impoundment during major storm events, they would need to identify a local financial sponsor to bear the full costs for the levees and for the costs for mitigative measures resulting from the construction of the levees. These costs are entirely non-Federal expenses. It is noted that the Corona Airport is located on lands owned by the Federal Government for the purpose of flood control and all investments in this location were made with the full knowledge of the flood threat. As our recommended modifications will not result in more frequent or longer durations of flooding, the Corps did not include flood protection features at this location.

VOLUME 5

OAK STREET DRAIN

ERRATA

Figure 9 (Page IV-19). The title "Residual Overflow Area with 100-year Design Project" should be revised to "Standard Project Flood Residual Overflow Area with 100-year Design Project".